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with which is consolidated

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Larger Shoes for Plant Engineers

. . . Remember how little three year old Johnny used to clomp around the house in his dad's big shoes? Miles too big for him they seemed then. But time brings growth. Today Johnny has all he can do to crowd his feet into a pair of number tens.

. . . If you could put a plant engineer of twenty years ago, or even ten years ago, into the shoes of a representative plant engineer of today, he would find them as much too big for him as dad's shoes were for little John. For the responsibilities of plant engineers and others who aid him in the mechanical and electrical services to production have increased amazingly during that time.

. . . The plant engineer and his electrical and mechanical assistants are the men who in large measure determine the productivity of our plants, because it is their job to keep these plants running at top speed without interruption; to distribute and apply power to best advantage and to coordinate production activities through mechanical handling. Measuring the growth of his responsibilities merely by the growth of productivity, the plant engineer of today must be sixty-five per cent bigger than he of ten years ago, for productivity per man has increased just that much in industry.

. . . The plant engineer of today must be an executive as well as a technician. He must be an organizer and a planner. He must think ahead. He needs a vast fund of experience, other than his own, to draw upon. He needs the help that neighbor engineers can give him through frequent contact with them in local Plant Engineer's Clubs. He needs the influence and aid that can be brought to bear through the formation of a National Association of Plant Engineers. And he needs the help and guidance, in his daily work and future plans, of the best minds in his profession.

. . . The mission of INDUSTRIAL ENGINEERING is to serve the informational needs of the plant engineer and his electric and mechanical associates in the light of their progressing requirements and enlarging responsibilities. To this end its editorial program and contents are shaped. We feel the need, however, of enlarging that service and giving it a flexibility that will bring to bear upon the individual problems of the plant engineer and his associates the experience, advice and help of the best minds in the profession. To this end, we are starting, next month, a Plant Engineer's Forum which will be a regular feature of each forthcoming issue. This will be in the charge of Mr. F. M. Gibson, Plant Engineer of the American Sugar Refining Company, who, as announced on page 252 becomes Consulting Editor to this publication.

. . . Through this means, we believe, a very practical way will be opened to aid the Plant Engineer to fill the larger shoes of future needs. For not only will it bring sound and seasoned experience and help to bear upon the specific individual problems of our readers, but it also will provide a practical means to aid in the formation of local Plant Engineer's Clubs and of their welding into a National Association.

. . . Plant Engineers, let us have your comments and let us help you solve your individual problems.

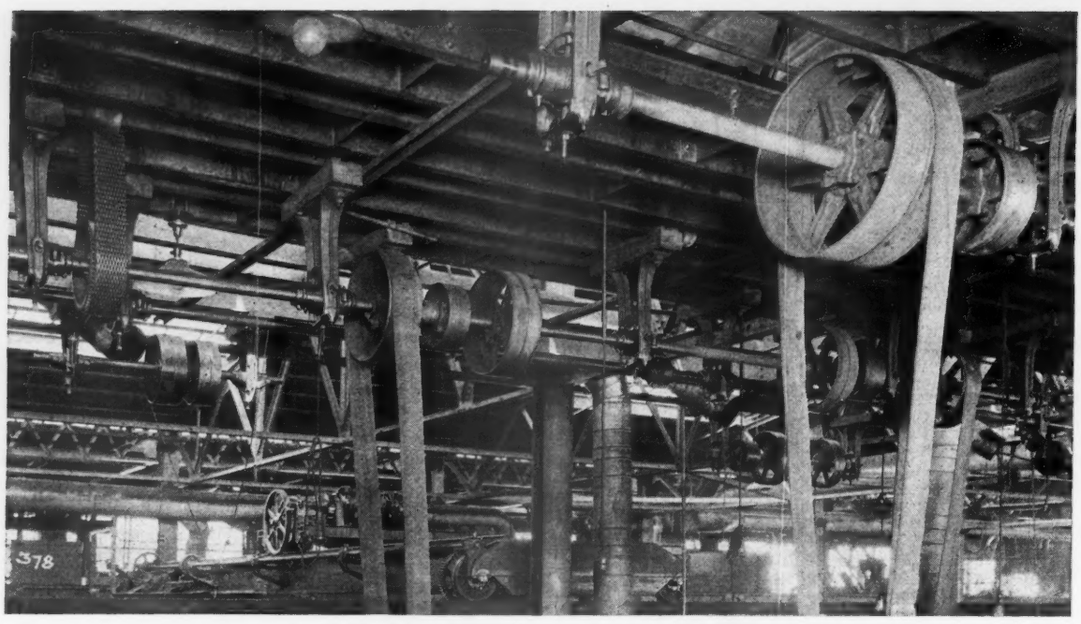

Fig. 1. Better bearings here added some 14 per cent to the productive power

Hidden Loss Reduction
in mechanical power transmission

THE MECHANICAL transmission of power enters into practically all industrial operations. It is the vital connecting link between power generation and the mechanical production of manufactured goods. Important in the days when a water-wheel, some rough gears, pulleys and ropes or belts constituted all the available equipment, the principles and practices of efficient power transmission have grown more important and more complex with the growth of mechanization in industry.

The trained draftsman and the engineer in charge of plant maintenance work have, as a rule, studied the theory of this subject, but theory alone is only one part of the equipment necessary; nor can theory alone solve some of the complex problems that are encountered in the modern plant. In the series of articles of which this is the first, it is planned to present a practical and comprehensive treatment of mechanical power transmission, based upon operating experiences, and written in such fashion as to require a minimum of technical training for its understanding and application.

By WILLIAM STANIAR

Chairman of the Advisory Board, Power Transmission Association; Power Transmission Engineer, E. I. du Pont de Nemours & Company and General Motors Corporation

If we were to say that power transmission is an exact science, with fixed rules and formulas, we might be close to the truth; but we might also scare away the interest of many men who would stand to benefit from the experience that is to be summed up here in useful form. Suppose we forget science, for the moment, and forget the fact that as in every science, while there are undoubtedly fixed rules and formulas governing every phase of operation, some of these formulas are as yet imperfectly understood. Instead, suppose we approach the subject not with the idea of cramming ourselves with theories, but with the realization that it is only a means to an end; that the most beautifully designed, theoretically perfect installation is worthless unless it accomplishes the object of transmitting power with minimum loss, maximum efficiency, and minimum maintenance.

We start, then, with power at one end of the line, and at the other end the machines which are to use that power in producing manufactured goods. For every 100 hp. available at one end of this line, we want to deliver as nearly as possible to 100 hp. at the other end. The difference (for it is both practically and theoretically impossible to transmit power without loss) represents a measure of efficiency of the power transmission system. In actual practice, however, we have to go farther than that. We have to take into consideration two more factors; the cost of the installation, and the cost of maintenance. Unless we keep that in mind, we will go astray. It is not conservation of power, but conservation of power cost, that we are after.

There have been, and probably always will be, enthusiasts who greet each new development as a cure-all; some who insist that direct motor drive solves all problems; others who would condemn all plain bearings in favor of one or another type of antifriction bearings; still others who insist that group drive is the only logical drive method. The fact remains

that industrial plants today are successfully employing a wide variety of drive systems, and the millennium is just as far away as ever.

Taking industry as a whole, probably the most widely used system of transmitting power to production machinery is what is known as "group drive." Whether this is the "best" method, is one of the controversies that make life interesting. The fact remains that it is employed to a greater extent than any other method of drive. The group drive system consists essentially of splitting up the machines into groups, and driving each group by means of a motor, short line shaft, and individual belts to the machines.

While the group drive system is most extensively employed, it is by no means universal. There are cases where direct motor drive to each machine is best; other cases which call for individual motors for each machine, but with a belt as the drive medium; still others where chain drive, or gear drive, or rope drive, affords the most efficient solution; and various combinations of several drive methods are often resorted to.

What actually determines the final choice of a drive method is a combination of factors, each one of which narrows down the possible field by a process of elimination. First of all is the matter of available space, and close on the heels of this comes the matter of speed ratios. For moderate ratios, with ample space, economy and efficiency both might dictate a straight belt drive. Where space is limited so that correct center distances are out of the question, the only way to employ a belt is by means of some one of several available idler devices. Again, where high ratios are necessary, it is poor economy to attempt to secure these without resorting to one of the modern types of speed reducing units. For example, it is possible to obtain a speed ratio of 100 to 1 by means of several steps involving a multiplicity of pulleys, shafts and belts, but it is neither efficient nor economical.

The general tendency with respect to machine tools which operate only intermittently, is to drive these by individual motors either through a direct coupling or by belt. Similarly, extremely large machines are best driven individually; whether direct-coupled, through speed reducing gears, by belt, or by chain, being a matter determined by the particular conditions.

Where space is sufficient, and where machines are operated continuously, the group drive system is sufficiently flexible in its application to offer certain advantages. Not the least of these, is the fact that the size motor required is determined by the running load rather than by the starting load of all the machines in each group.

Generally speaking, there is no excuse today for the distribution of power by means of long lines of heavy shafting, with many wide belts to countershafts; the old, cumbersome method of years ago. Such an installation is a tremendous waster of power, to say nothing of its being a source of constant trouble from a maintenance standpoint. Even where a relatively cheap central source of power seems to furnish an argument in favor of such a transmission layout, it will usually be found that this is a short-sighted fallacy. In actual practice, it has often been found more economical and infinitely more practical to couple such a power source to a generator, using electric motors for an intelligent application of group and individual drive principles.

Only a few years ago the writer encountered a case where a plant was subject to constant interruptions due to bearing failures, belt failures, and overload on the 50 hp. motor used as a prime mover. Following through the existing layout, this motor drove a headshaft at a 7 to 1 ratio by means of a stiff belt; introducing a 10 to 15 per cent slip at the small diameter motor pulley. The line shaft was in turn belt driven from the headshaft, by a short-center, small pulley diameter belt drive; requiring tight belt, with excessive strain on both belt and bearings. From the line shaft, another heavy belt drove a countershaft (by means of a small pulley, with consequent slip) and this in turn served to provide the proper speed for driving a grinder; the last-named drive being a vertical belt drive. There were more details in connection with this installation, but these are sufficient in conjunction with Fig. 2 to give a general idea.

By mounting the motor overhead (Fig. 3), driving the line shaft direct by silent chain, revising the speed ratios and installing proper belts—in other words, by applying modern power transmission engineering—all the wasteful features were done away with, and resulted in a power saving of more than 15 per cent. This, however, was only one of the savings effected. Among the other factors which contributed to the right side of the balance sheet were such items as decreased maintenance costs on motor, belts, and bearings; decreased repair and replacement costs, and avoidance of periodic shut-downs.

In plants built within the last few years, granting due regard to engineering progress, the transmission equipment may be assumed to be efficient. But in the case of older plants, especially those which have increased their production materially, or which have changed their original machine layouts, the opportunities for im-

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FIG. 2. SCHEMATIC LAYOUT of a power transmission system which was in actual operation for a number of years. Note the many factors that helped to waste power.

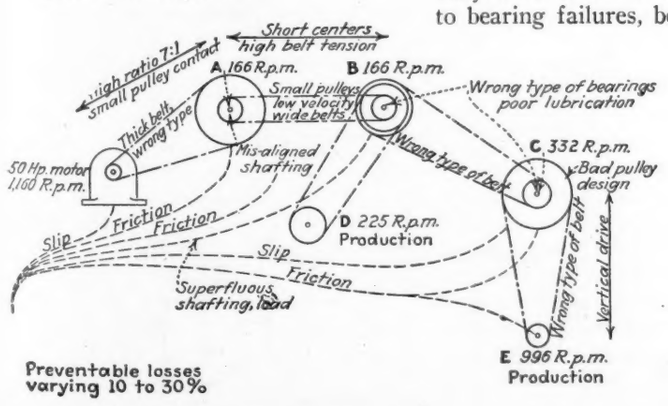

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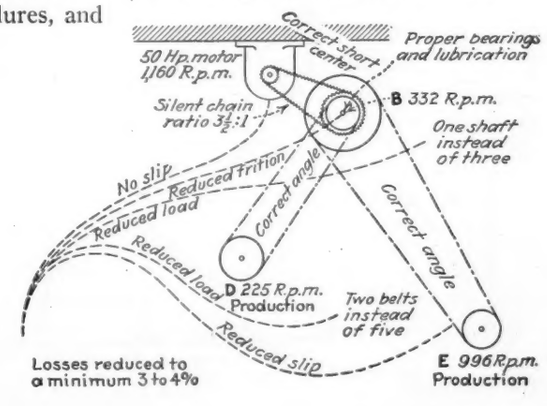
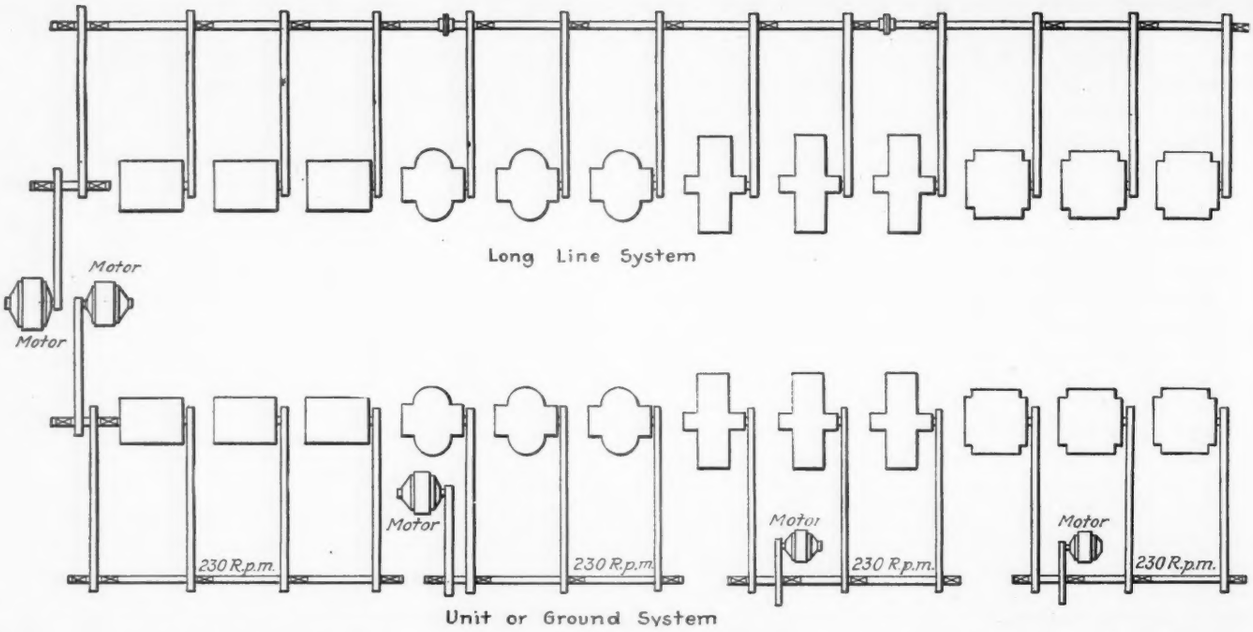
FIG. 3. THE REVISED SYSTEM of drive for the shop whose original layout is shown in Fig. 2. The same motor is doing the same work, but without overload or excessive maintenance.





provement are quite often startling.

First of all, it must be remembered that progress in the solving of difficult transmission problems has been extremely rapid in the past few years. A first class transmission layout of even ten or fifteen years ago, may be quite obsolete in the light of the knowledge and equipment available today. Again, while such a plant may have operated with fair efficiency as originally planned, an added drive here and a rearranged machine layout there has introduced factors not originally planned for.

It must be recognized that there are a great many instances where the use of shafts and belting is a mistake; cases which call for roller chain or silent chain, for direct coupled speed reducer drive, and so on. Each system for transmitting power has its merits, and in succeeding articles these will be discussed in detail.

FIG. 4. THE ESSENTIAL DIFFERENCE between the long line system and what is known as the group system of power transmission. The former is, generally speaking, indefensible in the light of modern knowledge and available equipment.

* * * *

Aside from actual changes in the general layout of the mechanical power transmission system, there are many plants where worthwhile economies could be realized through modernizing some one or several items of the equipment in use. For close quarters, the modern short-center-drive devices of various makes have proved their worth. Properly designed bearings have a large influence on the power bill as well as on the cost of maintenance incidental to operation. Ring oiling, capillary oiling —each has its advantages; anti-friction bearings of various types are available, and are being used to an increasing extent in industrial service.

It is both theoretically and practically impossible to transmit to the machines anything like one hundred per cent of the power delivered by the power source. But it is not only possible, but profitable, to correct any and every transmission condition which imposes an avoidable tax on the power bill. For example, a test run under the writer's observation, a few years ago, disclosed that the replacement of one type of bearings with a more modern type resulted in a power saving of 14.4 per cent, and this, aside from the savings on maintenance, due to more efficient lubrication provisions. Yet this was but a single instance, typical of many.

Whether it be bearings, or belts, or clutches; whether wrong equipment or wrong layout; in almost every plant that has been in operation for more than a few years there are opportunities for improvement.

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FIG. 5. A HIGHLY INEFFICIENT MIXER DRIVE which was costing $850 in annual maintenance alone, in addition to the excess power costs.

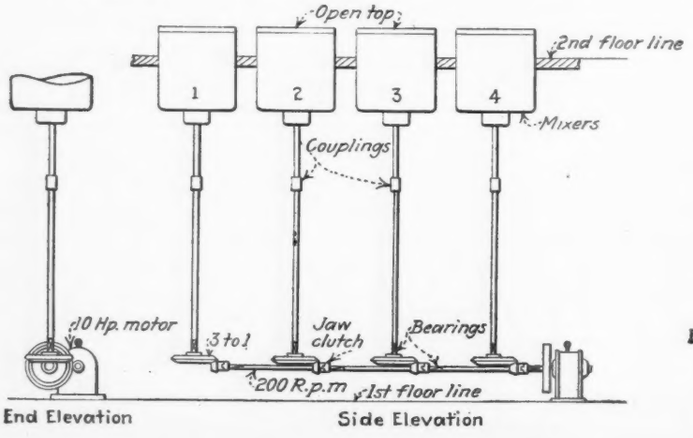
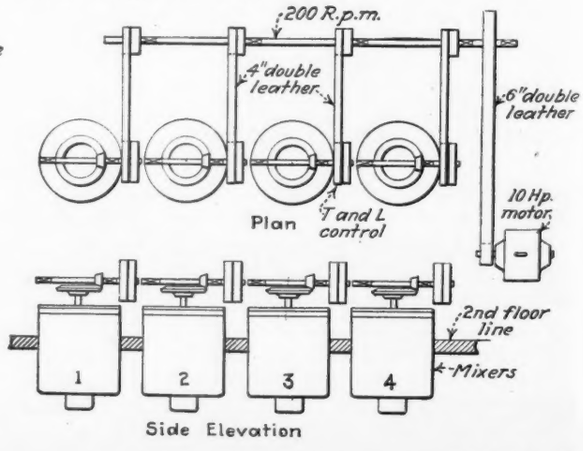


FIG. 6. THE REVISED DRIVE for the mixers shown in Fig. 5. The changes cost $1,100 and resulted in savings of more than $1,000 a year.



Lightning Arresters

Factors that influence their selection and installation

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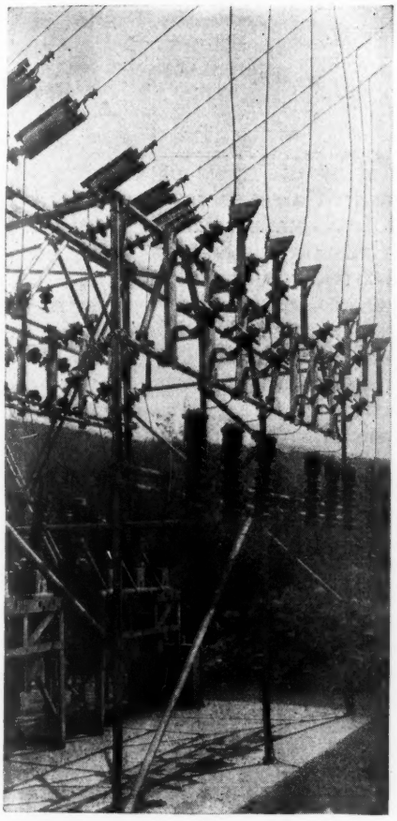

Fig. 1—A 25-kv. substation with two feeders, each of which is protected by distribution-type lightning arresters.

IN MOST locations, outside of California, lightning is a common occurrence at least during the summer months. In these less favored locations, overhead electric power lines are subject to direct strokes of lightning and more frequently, to indirect or induced lightning. In either case, voltages that are high as compared with the normal working voltage may appear on the line.

Experimental work on transmission lines has shown that these voltages are limited only by what the line insulation will withstand without failure. Voltages of 1,800,000 and more have been recorded on 220,000-volt transmission lines. The highest overvoltage appears on the circuit where it is struck by lightning, or in the case of lightning induced by a cloud. The amount of circuit directly affected is only a little greater than the diameter of the cloud and probably never exceeds 1 mile.

The largest part of the usual circuit is outside of the station and, therefore, the line is more likely to be directly affected. However, the stations connected to the line will be affected to some extent because a surge or traveling wave of voltage is generated in the vicinity of the cloud and travels in both directions along the line, the voltage of each surge being one-half of that generated under the cloud. The current in the surge equals the voltage divided by the surge impedance, or characteristic impedance, of the line. For overhead lines this impedance is about 500 ohms.

When a surge reaches the open end of a line, the current is necessarily reduced to zero and the voltage is doubled. This condition is approximately realized where the line terminates in inductive apparatus, such as a transformer or motor. On the other hand, if the line terminates in a dead ground or large-capacity condenser, the surge voltage becomes zero, and the surge current is doubled. From these facts it can be seen that unless an arrester is able to discharge more current than there is in the line, the surge voltage will not be reduced.

Lightning causes the highest line voltages at the storm center and at points of reflection, such as open ends of lines. At these places the surge voltages may be very high, high enough to cause a flashover on a line insulator, circuit breaker or transformer bushing, or even to puncture transformer insulation. Such an insulation failure will cause a service interruption at least. In the case of apparatus failure, there will be a longer interruption and time and expense will be required for making repairs. It is for this reason that lightning arresters are found to be economical in many stations, in order to reduce or altogether eliminate interruptions and apparatus damage due to lightning. Whether arresters will be economical in any given case will depend upon conditions, such as lightning severity, the degree of exposure of the line to lightning influences, importance of service continuity, and value of connected apparatus.

The general principle used for obtaining protection by means of arresters is that of reducing the surge impedance at the apparatus to a value less than that of the line. This can be done by shunting the comparatively high impedance of the apparatus with an arrester having a surge impedance less than that of the line. For a theoretical arrester having a resistance R, the ratio of the voltage across the resistance to that in the line is $2R \div R + Z$, where Z is the line surge impedance. The smaller R is, the lower will be the voltage at the arrester. However, if the arrester has no resistance, while its voltage is zero, and the current is double that in the line, there is no absorption of energy and the surge is reflected without loss and may reappear at another point on the circuit.

Resistance is only one of the characteristics of an arrester. Being a shunt device, line voltage is applied to its terminals continuously and the problem of preventing the flow of power current is one that requires considerable ingenuity for its satisfactory solution.

At one stage in their development

arresters consisted of combinations of gaps and resistances. As system voltages and powers became greater, this principle became inadequate, and so the "valve" principle was developed. This can be explained by reference to Fig. 2 which illustrates the volt-ampere characteristic of an ideal valve-type arrester. An arrester with such a characteristic will impose a definite upper limit to the surge voltage, and yet, as the characteristic never falls below the line voltage, no power current can pass through the arrester.

In reality all arresters depart somewhat in characteristics from the ideal shown in Fig. 2 and, in order to deal with practical conditions, we must consider an available arrester. For

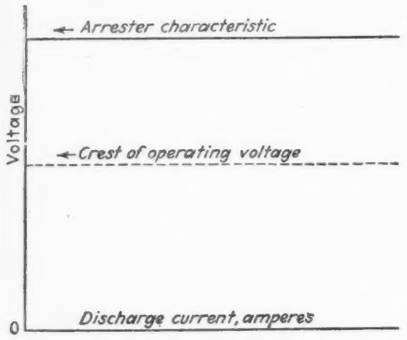

FIG. 2 — VOLT-AMPERE CHARACTERISTIC of ideal valve-type arrester. The arrester characteristic, or voltage at the arrester terminals during discharge, is made sufficiently higher than the maximum operating voltage to prevent the passage of power current through the arrester when it discharges.

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example, we will refer to the autovalve arrester.

The autovalve principle imparts the valve characteristic to an arrester of the spark-gap type. For a spark-gap to possess valve characteristics, it is necessary that the breakdown voltage and the voltage across the gap when current is flowing should be at least approximately equal. Current flow across an air gap may be in the form of an arc or of a glow discharge. The voltage of an arc is low, 50 volts or less, while that of a glow is on the order of 350 volts. For practical reasons, the glow discharge is preferable because of the higher voltage. Investigation has shown that up to 5 mils gap length the glow discharge voltage is practically constant over a wide range of current density, which is a further desirable characteristic of the glow discharge.

If the gap electrodes are made of a material of high resistivity, compared to that of metals, the discharge is distributed over the face of the electrodes, the current is prevented from concentrating in any local area, local heating is not possible, an arc cannot form, the discharge is maintained as a glow, and the voltage drop is stable at about 350 volts.

Assuming that the glow discharge principle will be used, it is necessary that the breakdown voltage also be in the vicinity of 350 volts. Investigation shows that the breakdown voltages of very small gaps is as shown in Fig. 3. This means that for the required 350 volts, the gap length should be such as to give the minimum breakdown voltage for air at atmospheric pressure, or about 0.0003 in. It would appear to be impracticable to do this. It has been found, however, that the same characteristic can be obtained with a longer gap if the gap is placed along insulating material.

The practical arrester consists of one or more columns of flat disk electrodes composed of a special resistance material. The electrodes are separated around the circumference by a thin mica washer. For any particular voltage rating it is necessary only to place in series a sufficient number of elemental arresters composed of electrodes and spacers, so that the characteristic curve is safely located above the line voltage. Then any desired surge impedance may be obtained by using an appropriate electrode surface area.

Practically, these requirements are

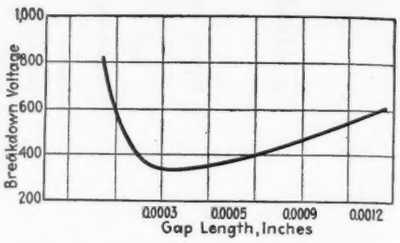

FIG. 3—THE BREAKDOWN VOLTAGES of small air gaps vary as shown here.

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filled by two types of arresters. A standard arrester for the protection of large stations has four electrode columns in parallel per phase. Such an arrester is shown in Fig. 4. The elements of this arrester, shown in cross-section in Fig 5, consist of four electrode columns housed in a wet-process porcelain casing. Wet-process porcelain is the standard insulator material and is not subject to deterioration, as are certain organic insulating compositions.

In addition to the factors which control performance, it is necessary in selecting or designing lightning arresters to take account of economic factors. An arrester that gives perfect protection, but which costs more to install and maintain that it is worth in saving service delays and protecting apparatus, is not justified. As it is easily possible to make ap-

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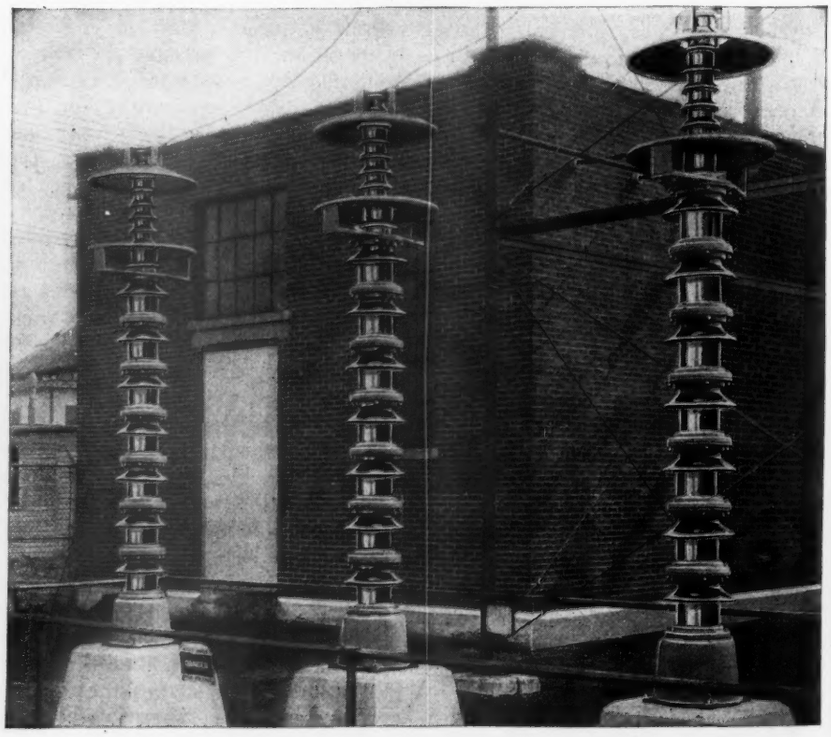
FIG. 4—A 73-KV. STATION-TYPE autovalve arrester with special, enclosed gap.



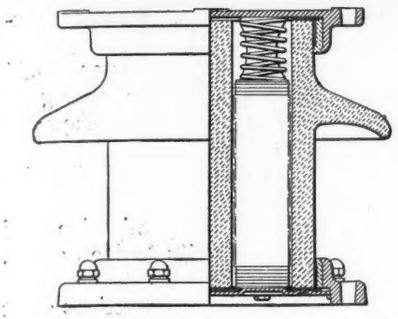


FIG. 5—CROSS-SECTION of one unit of a station-type arrester for ratings above 37 kv.

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preciable reductions in manufacturing cost by a reduction in disk area, distribution-type arresters, Fig. 6, have been developed having a single column of disks, also inclosed in a wet-process porcelain case. This type of arrester has approximately three times the surge impedance of the corresponding station-type arrester. It is made in ratings from 350 to 50,000 volts and is single pole, whereas the station-type arrester is a three-pole design, for three-phase circuits.

An arrester has certain limitations that should be recognized in its application in order to obtain the most economical protection. For example, an indoor arrester is not adapted to outdoor service, because it would have insufficient protection from the weather.

Arresters are always given a maximum voltage rating and sometimes a normal rating as well, for example, 25,000 volts maximum and 22,000 volts normal. The latter, of course, is the circuit voltage for which it is intended. The maximum rating is usually about 10 per cent higher than the normal. The maximum rating is proportional to the valve characteristic voltage which if exceeded might result in power current passing through the arrester at the time of a discharge. If this is not prevented, the arrester may fail. Therefore, it is important that the line-to-ground voltage of the circuit never exceed the maximum rating of the arrester.

The arrester characteristic is the voltage at the arrester terminals during discharge. If this is very high compared to the circuit voltage, the insulation of the circuit will be stressed correspondingly, and the protection will be poor. Therefore, the protection will be most effective when the arrester is worked right up to its safe maximum.

In general, the circuit voltage that is to be considered in applying arresters is the line-to-line, or delta voltage. For example, a circuit with 23,000 volts between wires would require a 25,000-volt arrester. However, it is becoming common practice to ground the neutral and use standard 13,200-volt transformers connected in star on such a circuit. Obviously the best protection for 13,200-volt apparatus is not obtained with 25,000-volt arresters, but rather with 15,000-volt arresters.

These lower voltage arresters may safely be used, provided the voltage from line to ground never exceeds the arrester rating. At the point where the neutral is solidly grounded, the line-to-ground voltage is that of one transformer and the arrester rating can be based on the transformer rating. At other points on such circuits than that where the ground is located, the neutral is not so stable and it is generally necessary to base the arrester rating on the line voltage. It is common practice on high-voltage

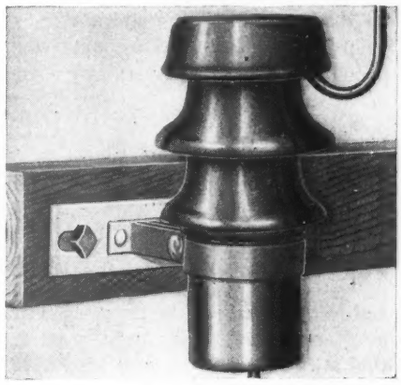

FIG. 6—A 7,500-VOLT DISTRIBUTION-TYPE autovalve arrester. This type of arrester has a single stack of discs, housed in a porcelain case.

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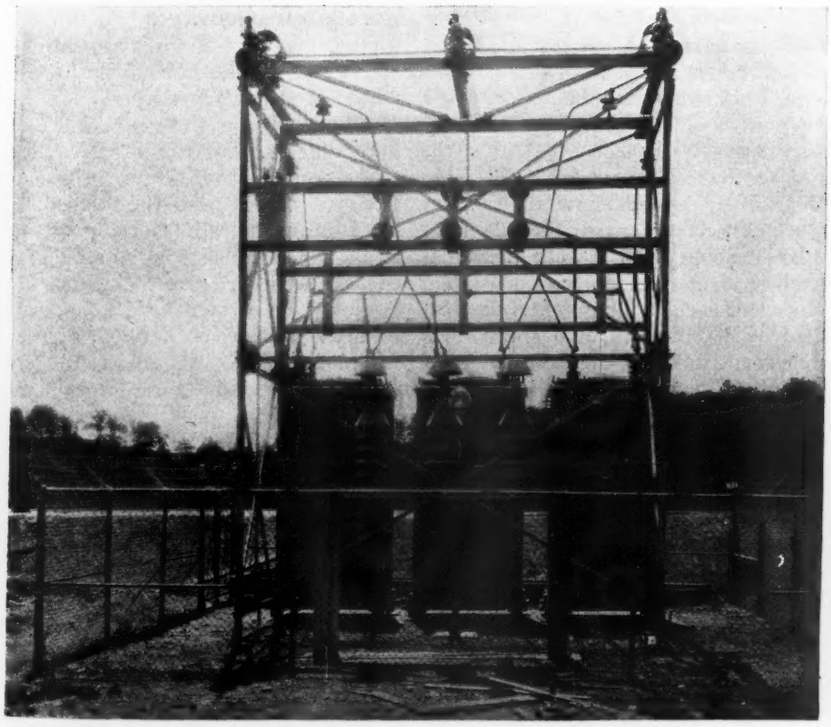
systems to ground the neutrals of all transformer banks and to use arresters having full insulation but a rating of about 80 per cent of line voltage.

The choice between a distribution- or station-type arrester for a particular application is one of economics, depending upon the value of the apparatus and service continuity. There are some cases where station-type arresters would be warranted but the space is not available. In such cases, one solution is to install two or more sets of distribution-type arresters. If a station bus is fed from more than one feeder, a good plan is to use distribution arresters on each feeder. These arresters are virtually in parallel and thus furnish more protection than a single set. Such an installation is shown in Fig. 1. Another desirable feature of such an arrangement is that the end of the line and circuit breaker are protected when the breaker is open.

Surge studies of different station layouts has shown that considerable differences in protection may be ex-

FIG. 7—STATION-TYPE ARRESTERS are used in this 25-kv. low-tension substation.



pected from them, because of reflections and refractions within the station. It is desirable to lay out the station so that the least surge voltage occurs at the apparatus, and the highest voltage at the arrester terminals, under the hypothetical condition that the arrester is an open circuit.

If a feeder terminates in a transformer it may be subjected to double the line surge voltage, whereas if the feeder loops through the station, the transformer surge voltage cannot exceed that on the line. Voltages will be still lower if two or more feeders loop into a station, provided they traverse different routes so as not to be simultaneously influenced by the same lightning discharge. Incidentally, severe surges can be expected at the ends of double-circuit lines that are carried on the same poles.

The best practice is to locate the arrester as close as possible to the apparatus to be protected. An arrester gives protection by first reducing the voltage at its own terminals, and then transmitting a wave of reduced voltage to the connected lines and apparatus. Meanwhile, part of the surge energy passes directly to the apparatus, the effects of which will be minimized by making the connections between arrester and apparatus as short as possible, although they always have some length. Consequently, when a surge comes in over a line and arrives at the arrester tap, the energy will divide equally, because both branches have the same surge impedance.

If the connection to the apparatus can be made of higher impedance than that to the arrester, the energy division will no longer be equal and the voltage at the arrester will be higher than at the apparatus. An inductance has a higher surge impedance than a straight wire, and, in the form of choke coils, is used for improving the protection afforded by an arrester. Practical choke coils do not introduce any appreciable impedance at the working frequency and current.

The ground connections are an important part of the protective circuit, and should be as short and direct as possible. These connections have to carry the arrester discharge, which in the case of a three-phase arrester, may easily reach a value of several thousand amperes. The voltage drop in the ground connection adds directly to the arrester voltage and subtracts from the protection. This effect can be eliminated, however, by interconnecting the arrester and apparatus grounds, at the same time reducing the effective ground resistance.

A ground that might be satisfactory for a single arrester on a low-voltage circuit probably would not suffice in a larger station. Also, a three-pole arrester requires a better ground than a single-pole arrester. To be specific, a ground resistance of 1 ohm or less will do for most large stations, but 100 ohms would be high for any arrester.

When lightning protective apparatus is selected and installed with a knowledge of its capabilities and limitations, the station operator can expect his troubles from lightning to be reduced to a negligible amount without hazard to the protective equipment. Points that should be taken into account for efficient protection are:

1. The line voltage to ground should approach the arrester maximum rating.
2. The cost of the arrester should be balanced against the saving in equipment and service delays to determine its type.
3. Additional arresters give increased protection.
4. Avoid the termination of feeders, and especially double feeders, at a station.
5. Make arrester connections short and direct.
6. Compensate for length of connections by means of choke coils.
7. Reduce the resistance of ground connection.
8. Interconnect station grounds.

The safety of the arrester requires that:

1. The line-to-ground voltage should never exceed the maximum rating of the arrester.
2. The insulation of the arrester should be adapted to the service conditions—moisture, dust, etc.

Fabric Wheels and Casters for Noiseless Trucking

ELIMINATION of unnecessary noise in offices and factories is a problem confronting service executives who are working to improve conditions related in any way to the output of their organizations.

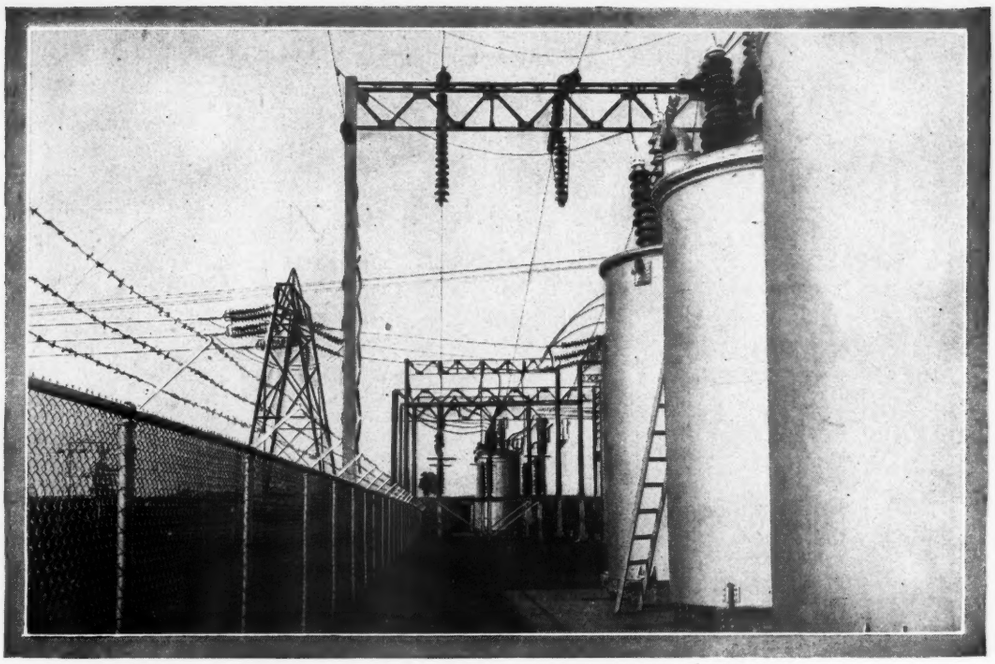
The attention which this problem has been receiving in recent years has given impetus to the use of cushion truck wheels and casters made of cotton fabric, according to a survey just completed by the New Uses Section of The Cotton-Textile Institute, Inc.

Tests have been made by the War Department which show that cotton truck wheels are more durable than other cushion tired wheels on industrial trucks. By subjecting the two types to a carborundum wheel under a load of 400 lb. and at a speed of 5 miles an hour it was found that the other cushion tires disintegrated after traveling 162.66 miles in this test. The fabric wheel showed no appreciable wear after 372.2 miles. In more than fifteen years the manufacturers have not heard of one of their wheels that has worn out, it is claimed. In many instances a set of fabric wheels has outworn several truck bodies.

Fabric wheels will not chip or cut, and because of their cushioning effect they have been found more desirable than metal wheels from the fact that they are more quiet and less destructive to all floor surfaces. These factors are of importance in many industrial plants, offices and public buildings where the floors are made of more expensive materials and where silence in rolling equipment enables better service or an uninterrupted output. High temperatures and moist floors have little if any effect on fabric wheels.

The fabric for these wheels is cut into diagonal strips. From these strips segments of the proper dimensions are so cut that when assembled in ring formation the wearing surface of the wheel consists only of the ends of the cotton fiber. After the assembly the segments are compressed to approximately 50 per cent of their original size to secure greater density. Into these solid fabric rims, steel center plates and a flanged hub are forced under pressure, and the wheel or caster is then riveted solidly together.

These wheels and casters are largely used in factories, banks, hotels, libraries, railroad stations, department stores, restaurants and laundries. Experiments are being made to determine if automobile truck tires can be successfully made by a similar process.



Liberal use of paint in the plant encourages good housekeeping

COLOR for the PLANT

By J. ELMER HOUSLEY

Electrical Engineer,
Aluminum Company of America,
Alcoa, Tenn.

ALUMINUM paint has been adopted for a variety of industrial applications in the past few years. The protection of iron and steel from corrosion is an interesting and ever-present problem, in the solution of which the author has found aluminum paint particularly useful. The following discussion is based on the results of four years' experience in the use of aluminum paint in repainting as well as in the painting of new construction work at a modern power development located in a region of heavy rainfall and extreme variations of temperature. The surfaces to be protected from the weather were cast iron, structural steel, black sheet iron, galvanized sheet, steel plate, and a small amount of concrete and wood.

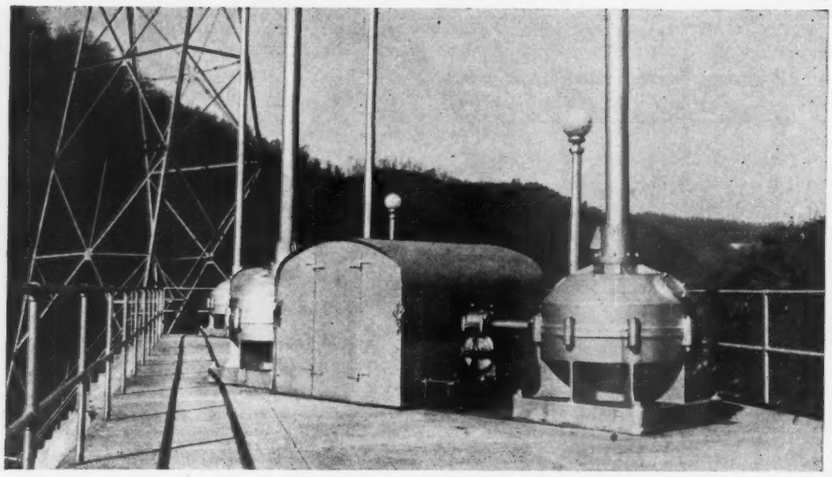
Aluminum paint with its metallic, flake-like pigment, is essentially different from other paints. Its special characteristics should be kept in mind in order to insure the easy application and the best service from this paint. The pigment is pure aluminum bronze powder made by stamping sheet aluminum into very small and thin flakes; this powder is then graded and polished to give it a lustrous and brilliant surface. Low-grade powder containing adulterants, such as mica, should be avoided. The paint is made by simply mixing the powder with the proper oil or varnish vehicle. As

> A discussion of four years experience in the use of aluminum paints for plant equipment.

the paint is brushed on the surface to be coated, the thin flakes align themselves as a film of metallic aluminum. This action is a surface tension effect and is called "leafing." This coat of metal is opaque to sunlight and protects the vehicle from destruction by the ultraviolet rays of sunlight. The weathering away of the metal film and vehicle is thus an extremely slow process. Standard Varnish Powder is the grade of aluminum generally specified for paints.

Varnish vehicles are well adapted for application to outdoor structural steel. They are very good for making aluminum paint because of their excellent spreading and covering qualities. Long-oil or "spar" varnishes, in particular, form with aluminum powder tough and durable paint films that are almost impermeable to moisture and quite resistant under severe atmospheric conditions. A long-oil varnish is one in which the amount of vegetable oil present exceeds the amount of gum or resin. To eliminate the necessity of excessive thinning, a varnish of just the proper consistency should be selected. The proper vehicle when mixed with standard varnish powder in the proportion of 2 lb. of powder per gallon will give a paint of satisfactory spreading and covering power.

Aluminum paint can readily be mixed on the job; so only enough for one day's use should be mixed at a



MOISTURE and severe weather have very little effect on painted surfaces like this. The aluminum paint does not crack or peel and expose the metal underneath.

* * * *

time. The proportion of 2 lb. of aluminum bronze powder per gallon of vehicle makes a paint containing about 21 per cent of pigment and 79 per cent vehicle. The weighed amount of powder should be placed in a suitable mixing container and the measured volume of vehicle then poured over it while stirring with a paddle.

By following these directions we secured uniformly good results in the application of this paint with both skilled and unskilled painters. The paint is free from sags and runs, and did not gum and pull under the brush. After three to four years' service the paint presents a silver-gray color, not unlike the appearance shortly after it was applied. The streaked or uneven discoloration present on other painted surfaces after a few years is strikingly absent. The paint film is extremely tough and resistant to abrasion, and no checks, cracks, or blisters have formed. No weathering effects are noticeable, and apparently the surface will not require attention for some years.

Surfaces to be painted were given various and apparently equally satisfactory treatments before painting. Some handrails, for example, were cleaned of old paint by a sand-blast which was available for a small portion of the work. The clean steel surface was primed with a coat of red lead as a rust inhibitive for the steel surface in exposed locations. Two coats of aluminum bronze followed, one 48 hrs. after the red lead. The second aluminum coat was applied about 48 hrs. after the first coat. Other portions of the handrails and flat steel surfaces were cleaned by scraping, using old files ground to a scraper edge. Where the old paint was not checked badly and rust had not formed under the film, the surface was brushed clean with a wire brush.

Lattice steel work and cast-iron surfaces were prepared with a wire brush. The original lead paint was about four years old and a large portion of the paint was removed because of checking and formation of rust spots underneath the paint film. All loose paint and scale were removed so that a clean and dry surface was presented. In the case of steel, all bare spots were primed with a coat of red lead. No painting was done on wet days or when the temperature was below 35 deg. F. On very cold days a small amount of mineral spirits was added to the vehicle before mixing in order to improve the spreading qualities of the paint. The dilution of the paint by mineral spirits is, however, to be avoided wherever possible.

Before painting on galvanized iron, such as transmission towers and corrugated iron buildings, the surface was allowed to weather for a month or two in order to secure better adherance of the paint.

About 40 transformer tanks, ranging in size from 100 kva. to 7,000 kva. were given two coats of aluminum paint. It is, of course, necessary to remove all traces of oil from any surface before painting. In the case of the transformers, the oil was removed by washing the surface with gasoline.

Most of the paint was applied by means of a brush, and the paint was well brushed out. The best results were secured by making all final strokes of the brush in the same direction. Good results are also obtained with spray application and this method is very economical where large areas or rough stone or concrete surfaces are to be painted.

The covering power of aluminum paint was found to be good on steel work; it ranged from 350 sq.ft. per gal. on small lattice work to 1,300 sq.ft. on smooth-surface steel tanks.

For painting wood structures the best results are obtained by using "kettle-bodied" linseed oil. The vehicle may be made by using 6 parts kettle-bodied linseed oil to 4 parts of volatile thinner. Two pounds of aluminum bronze when mixed with one gal. of the vehicle should show good spreading qualities and should not run or sag. Preferably, three coats should be applied to exterior work. For open-grained lumber or badly weathered wood, the priming coat should contain 1¾ lb. of aluminum bronze powder per gallon of diluted vehicle.

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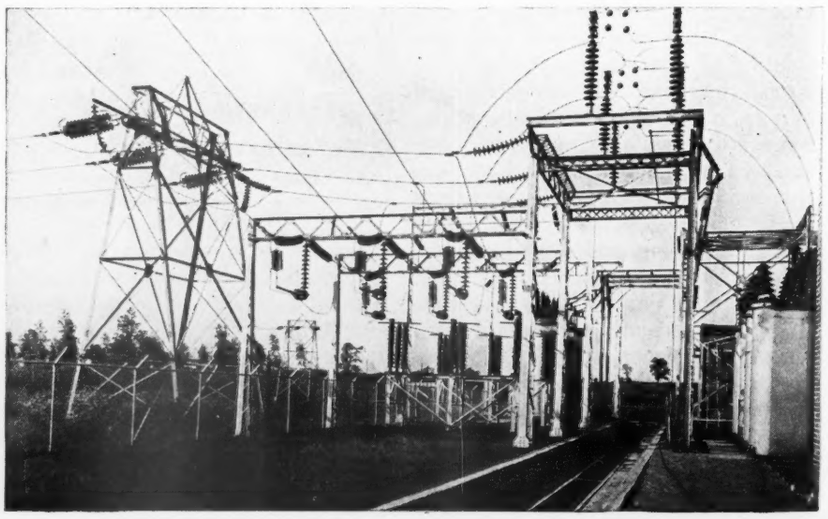
THE COVERING POWER of the paint was found to be especially good on this type of equipment, and ranged from 350 sq.ft. per gal. on small lattice work, to 1,300 sq.ft. per gal. on smooth surface steel tanks.



Motor-driven, centrifugal, boiler-feed pumps

How Service Requirements Influence

Pump Selection

E. J. GEALY

Assist. to Mechanical Sup't,
Pittsburgh Coal Company,
Pittsburgh, Pa.

PUMPING equipment, regardless of its application, should always be carefully selected. The idea that pumps could be chosen without weighing important facts and features connected with their design and service requirements has been proved false. Nowadays the high cost of labor, value of time and the many serious consequences which might result from a pump failure make it highly desirable to select each pump with consideration of the elements involved.

The labor necessary to install a pumping unit, like other machinery, is more costly today than ever before; consequently, whereas in the past a cheap unit that would quickly wear out could reasonably be considered, the economic stress under which business is carried on today necessitates the installation of a pump which, when once set up, need not be too frequently replaced.

Time is another important factor influencing the selection of equipment today. The time lost by various workmen who depend upon the successful performance of a pump must also be considered. If a poorly built pump is selected, its failure to function may soon result in a loss of many man-hour units of production.

Lack of water when needed, "floods" or an irregular flow of important liquids in industrial and general manufacturing processes may result in loss of life or property. Such losses soon justify the necessary expense of well designed and properly selected pumping units.

Economy of operation, durability and freedom from unwarranted repair costs should be considered in the selection of every pump. Frequently pumps must operate continuously or nearly so. When this is the case any small advantage in efficiency will prove to be an important factor. Here the question of power cost is involved and often it will be found that an additional per cent or two of higher efficiency will soon repay the extra cost of a highly efficient pump. In considering this point it is important

to choose a pump which will have a well sustained, high efficiency and one which may be operated so as to give best results at all times.

Durability, in most all cases, is a highly desirable feature in a pump. Not only is the design and construction of the unit important but also its suitability for handling the particular kind of liquid or solution it must elevate or circulate.

Excessive repairs are always costly. This is particularly true because the cost of the repair parts must be combined with the labor expense necessary to put them in place.

The selection of a pump depends largely upon the service to which it is applied. Some liquids must be handled in large quantities at extremely high or low heads. Other liquids, although small in quantity, might also have to be pumped at various pressures.

Many solutions contain acids or alkalis, others must be handled at high or low temperatures, while still others contain more or less solid material which is often of a viscous nature or even gritty.

Pumps for these various kinds of services quite naturally vary greatly. To meet these requirements units have been designed with porcelain plungers, cement-lined casings, lead packing and rubber or cast-iron fittings. Frequently, acidulous and gritty materials must be handled in pumps entirely or partly made of bronze, nickel or chrome alloys. For special service conditions pumps with renewable liners made of these materials can be obtained.

Most pumps today may be broadly classified into two main types, namely, centrifugal and reciprocating. Lately, centrifugal pumps have become quite popular even though they are generally less efficient than most reciprocating types. The selection of the proper type to use, however, depends largely upon the service conditions.

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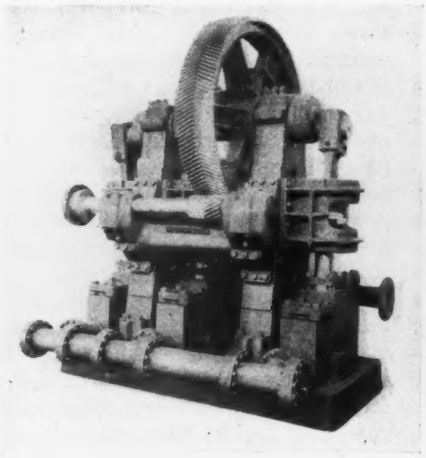
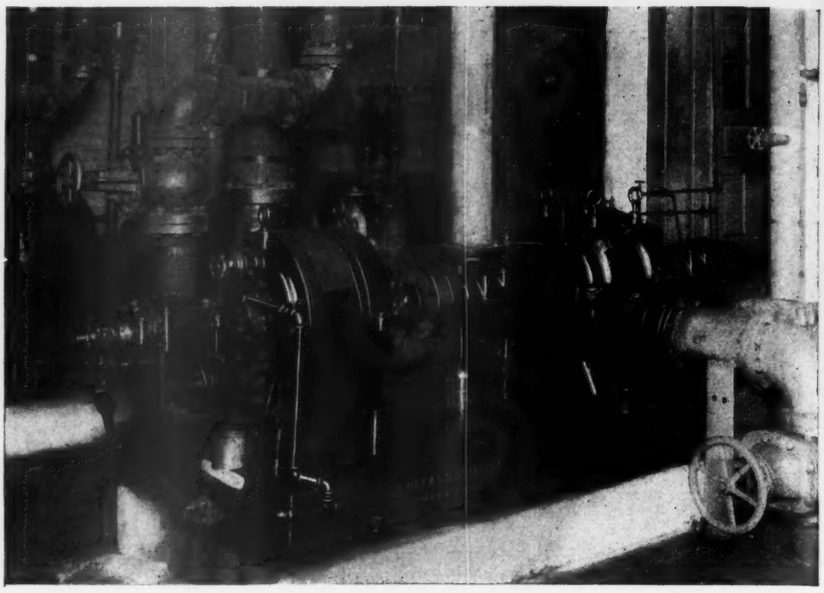
TRIPLE, VERTICAL, single-acting reciprocating type. Helical and herringbone gears are preferable on large reciprocating pumps because of the reduced vibration and the more easily sustained alignment of working parts.



Within recent years centrifugal pumps have been greatly improved in design and efficiency, and can now be obtained in sizes ranging from 1 in. to 20 in. or more. These units have been particularly developed to meet pumping requirements, such as city water supply, sewage pumping, service in filtration plants, underwriters' fire pumps, condenser pumps, paper mill units, and for a wide variety of services in industrial plants.

When selecting a centrifugal pump it is necessary to give careful consideration not only of its ability to withstand the operating conditions but care should be exercised in choosing a unit which will operate as efficiently as possible under the given conditions. It is entirely possible to purchase a well designed, highly efficient centrifugal pump and yet get low operating efficiency from it. This is because most centrifugal pumps must be designed for capacities and heads of certain more or less definite values and operate with a loss of efficiency under other conditions.



HIGH-SPEED, turbine-driven, two-stage centrifugals. Steam-driven pumps must be carefully balanced so as to minimize any vibrations which may develop in nearby machinery.

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Some of the latest improvements embodied in centrifugal pumps consist of anti-friction bearings and improved balancing devices. In any event, it is always advisable to select a pump which is designed so as to be at least partially inherently balanced. If the unit is a single-stage pump, a double-inlet impeller may be found advantageous. Two-, four- and eight-

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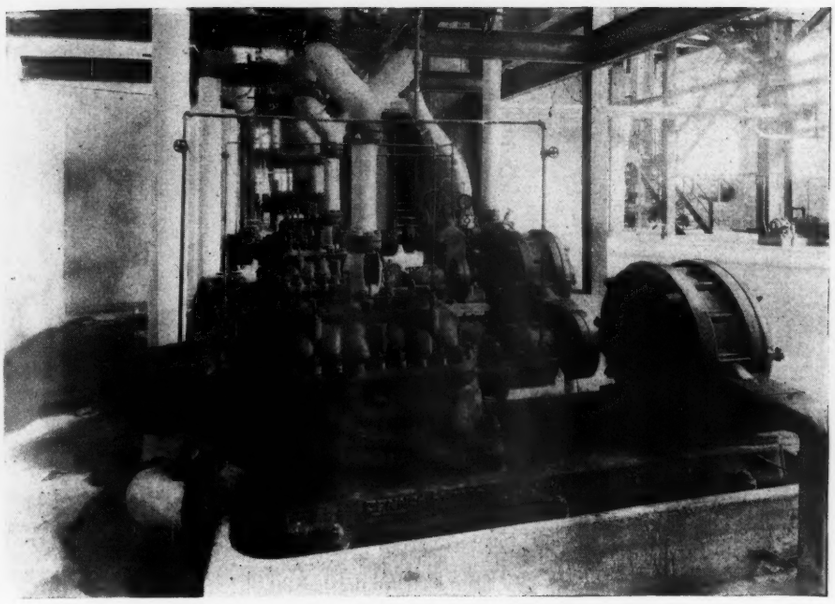
A PUMP ROOM can be made attractive in appearance. Centrifugal pumps have a distinct advantage in regard to the necessary floor space required. Several units representing a large capacity may be easily arranged in a limited space.



SIX-STAGE UNITS delivering 225 g.p.m. against 445 lb. Sturdy bases designed for both pump and driving motor contribute greatly to efficient operation and long life.

* * * *

stage types should be arranged to give a high degree of internal balance. In some pumps of these types this is obtained by pairing the impellers back-to-back whereas in other designs two separate pumps are designed and coupled together so that the end thrust of one is counter-balanced by the end thrust of the other. These features represent some of the most recent improvements made upon centrifugal pumps.

Before attempting to select a centrifugal pump for any desired service it is well to obtain a good understanding of the types available because their selection depends upon the conditions to be met.

* * * *

PUMPING LOAD is adaptable to synchronous motors. Twin, single-stage, double-suction, centrifugal units balance the thrust load on the bearings. These units are driven by 1,000-hp. synchronous motors.

Centrifugal pumps may be broadly grouped into two classes, namely, (1) turbine pumps, and (2) volute pumps.

Turbine pumps have an impeller surrounded by a stationary elemem called a diffuser. This diffuser consists of a number of blades cast integral with supporting rings or side plates. The passageway between the blades of the diffuser transforms the energy, in the form of velocity head, developed in the impeller, into pressure head. Diffusion vanes are arranged in the pump casing near the impeller and receive the water as it leaves the impeller.

The direction of a liquid, as it leaves an impeller, depends upon several elements; among them are, speed of the impeller, volume of water handled and head against which the liquid is pumped. There are still other factors but these are among the most important ones. Diffusion vanes function best when designed to take the water from an impelled when flowing in a given definite direction. Any deviation from this direction causes a turbine pump to operate less efficiently. Obviously, therefore, a turbine pump should be applied only where the elements of speed, capacity and pressure vary within rather small limits.

A volute pump has no diffusion vanes but instead has a casing built in the shape of a spiral or snail shell. This type of casing transforms velocity head into pressure head, due to its peculiar shape. The passageway of a volute enlarges in area in such a manner that the speed of the liquid leaving the impeller is reduced as it passes through the casing to the next impeller or to the discharge outlet.

Pumps of the volute type are advantageous for service where the liquid handled may become mixed with solid materials such as sticks and stones. Another advantage of the volute pump is that its efficiency is not so seriously affected by changes of pump speed, capacity or head. Abrasives in liquids would soon blunt the vanes in a turbine pump and thereby lower the pump's efficiency; a volute pump, however, does not not have this objection.

Incidentally, a pump with an open impeller, that is, one with the impeller blades cast on the surface of a single plate, is often used for handling liquids containing solid matter such as stones, dirt, pebbles, pulp and sticks.

Important construction features of both turbine and volute pumps should be checked carefully when making a purchase. The casing should be sturdy and have an ample number of holding bolts to keep the parts in alignment at all times. Special attention should be given to see that the

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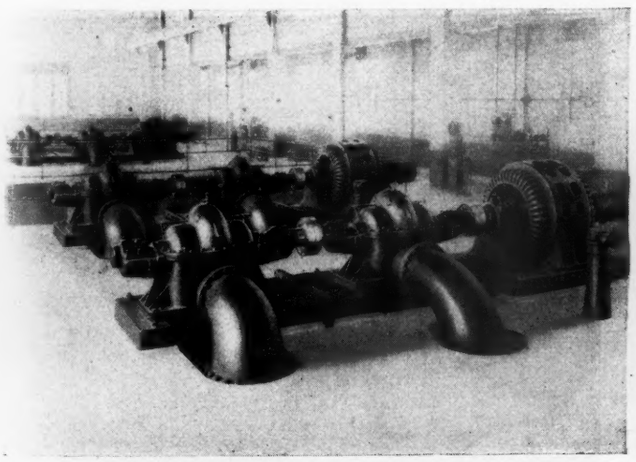
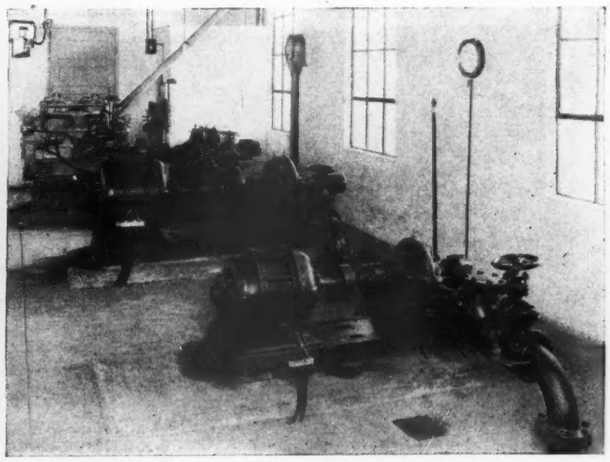
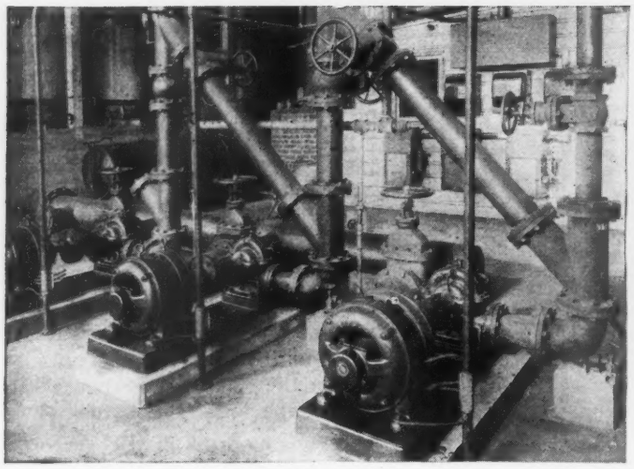
THREE DIFFERENT TYPES of pumps are used here. The three-stage unit in the background is connected to a gasoline engine. The pump in the foreground is of the single-stage type and the second one, a two-stage unit.







WELL ARRANGED PIPING adds to the appearance. Here the piping is laid out to permit interchangeability of connections. These milk pumps have double-suction impellers to reduce the wear on the thrust bearings, which would otherwise be severe.

* * * *

water passageways are smooth and to avoid abrupt changes in direction which would affect the velocity of the liquid. Impellers should have long well-fitted hubs. The shaft spans should be short, thereby reducing deflection and insuring absence of vibration at any speed.

Reciprocating pumps are generally more efficient in operation than are the centrifugal types but the large number of wearing parts, need for greater attention and greater first cost have led many pump users to choose the simpler centrifugal pump.

Pumps of the reciprocating type, however, have a definite field of usefulness which cannot be invaded by centrifugal types. Wherever positive pressures of relatively high values are necessary the reciprocating pump must generally be used.

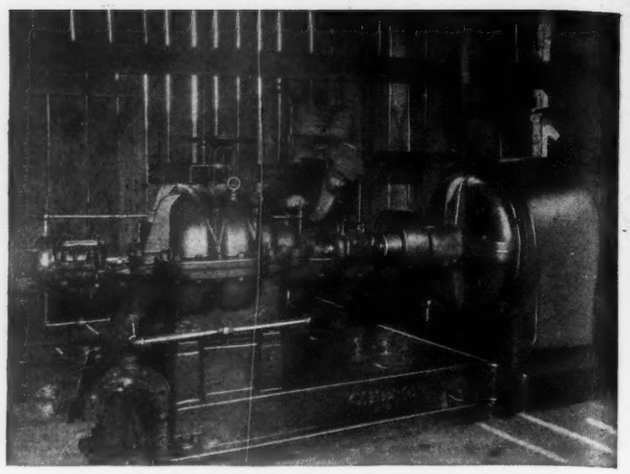
* * * *

STEAM TURBINE connected through reduction gears. When it is necessary to step-down the input speed herringbone or helical gear reduction units are commonly used. This single-stage circulating pump handles 12,500 g.p.m.

Reciprocating pumps have many features of construction which should be thoroughly considered before being purchased. Unfortunately users of pumps are so many and the services so varied that much encouragement is extended to would-be pump manufacturers who have neither the facilities nor engineering skill to build a good, serviceable pump. For this reason much pumping business has been lost by manufacturers who have spent both time and money designing and perfecting highly efficient pumping equipment.

Gears should be machine cut from the solid after the more has been drilled to insure against any undue binding or looseness. Pinions made of rawhide or other special nonmetallic materials will always greatly reduce noise and vibrations.

Air chambers should be a component part of reciprocating pumps because when so purchased they can be designed of sufficient capacity and size to meet the operating limits of the pumping unit. Frequently when air domes are not purchased as a part of the pump itself they are of insufficient size or improperly placed and cause considerable trouble.



PUMPS SHOULD BE PROTECTED against the weather. This three-stage turbine pump, which is used in a quarry, is housed in. Thrust bearings, when arranged for water cooling, should be designed to prevent undue clogging of the jackets.

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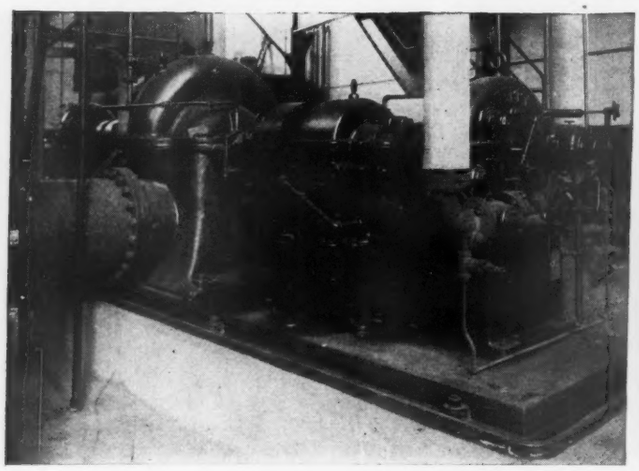
Another type of pump coming into more common use is the rotary pump. Units of this type are quite simple in construction and operation but must be accurately made to give good service. The cams or lobes should be machined to mesh and fit the casing closely to secure the minimum amount of slippage.

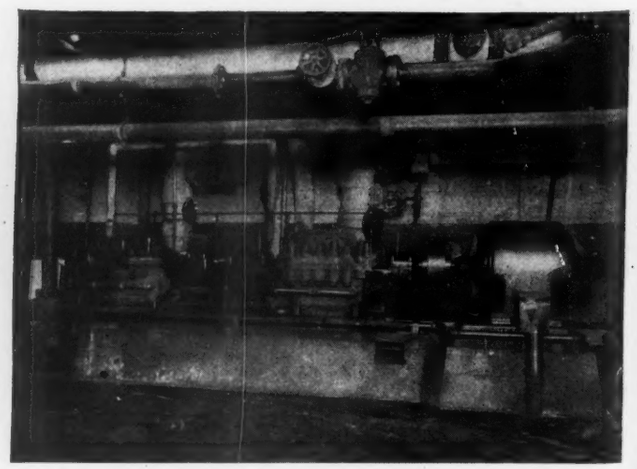
The three-toe type cam is quite popular for continuous service pumping chemicals, syrups, oils, and so on, whereas the gear type cams will give best operation on liquids which are not so solid or viscous.

The question of choosing a good pump for any service, whether it be in the oil, paper, process industry, and so on, hinges upon combining those features of design which have been worked out and proved satisfactory for the conditions involved.

* * * *

TWO PUMPS connected to a single motor. Notice particularly the substantial foundation and the flexible couplings on the shafts between each unit. Strong, well-designed casings are provided with ample clamping flanges.





Defective Commutation

. . . *Its Causes and Remedies*

By V. E. JOHNSON
Electrical Engineer, Milwaukee, Wis.

IN THE first article of this series, in the April issue, the general principles of commutation were discussed in some detail. Essentially, the commutator and brushes on a direct-current machine form the elements of a complex reversing switch. Considering the fact that the reversal takes place in the extremely short time required for a few commutator bars to pass under a given set of brushes, and that the currents involved are often very large, the severity of the service is at once evident.

A rigid analysis of the phenomena taking place during the commutating interval would include complex factors which are of no particular interest except to the design engineer. A knowledge of the elements involved is, however, useful in arriving at an understanding of the principles.

Elements Involved

A simple commutator with schematic coil connections is shown in Fig. 1. The current flows toward the neutral zone *N-N* and out into the brush through bars *3* and *4*. The load current in the coil between bars *3* and *4* must completely reverse itself during the time it takes for the bars to pass under the brush. During this period, too, this coil is short circuited and a local current flows which is a function of the reactance voltage in the coil and the resistance of the path through which it flows.

The reactance voltage is set up by the armature magnetism under load conditions, and varies with the design of the machine and the current in the conductors. The short-circuit current is by no means negligible, for it may in extreme cases exceed the load amperes.

Although in Fig. 1 the brush covers only two commutator bars, it may in actual practice have a much greater circumferential width. This feature is determined by the designer, who takes into consideration the field form and the conductor arrangement in the slots, and it is generally unwise for the operator to attempt to change it.

When flux distortion is partially overcome by brush shifting or by the use of compensating windings, the net short-circuit e.m.f. per brush is correspondingly reduced, but it can not in any event be completely eliminated for all load conditions. The remainder, therefore, causes a local current to flow which is limited principally by the brush resistance.

Poor compensation may be due to a variety of causes, of which the principal ones are:

(a) Incorrect number of compensating turns.

(b) Incorrect proportioning of the interpoles so that saturation and leakage affect the proper balance.

(c) With sudden load changes the compensating and armature fluxes may get momentarily "out of step."

Obviously, any increase in the net short-circuit e.m.f. due to inaccurate compensation will require a corresponding increase in the current-limiting resistance of the brushes.

Experiments indicate that the brush resistance is not entirely in the cross-section of the brush itself, but that a considerable portion of it is in the contact with the commutator bars. For example, the "chocolate" finish that was so much sought after on machines of older designs, undoubtedly owed some of its advantages to the higher contact resistance which it afforded.

Newly-sanded brushes or commutators may spark because the contact is more intimate than it was with the glazed, higher-resistance surface. On the other hand, if the brushes are rough-sanded so that only imperfect contact is made, the reverse may be true, and commutation will become worse as the resistance decreases.

Increasing the resistance in order to cut down the local currents cannot be carried on indefinitely, for the brush contact has a negative temperature coefficient and a point of equilibrium will be reached, due to the heating caused by the passage of the load current. Furthermore, brush losses will be increased.

Attempts have been made to improve matters by using brushes slotted in a direction parallel to the commutator bars, but this is not a commercially satisfactory arrangement. Machines have also been built with resistance incorporated in the windings, or in the commutator connections, but these are unusual designs and are not used today.

Sparking and Flashing—Modern machines are designed to operate satisfactorily without brush adjustment. This, however, does not necessarily mean "black commutation," that is, the entire absence of sparking.

U. S. Navy Specifications

The generator shall operate with practically sparkless commutation (practically sparkless commutation shall be understood to mean an entire absence of sparking other than fine pin-point blue sparks along the edges of the brushes; heavy or any yellow sparks will not be acceptable) throughout its range of rated capacity and under gradually changing load conditions without adjustment of its brushes. Successful commutation is such that neither brushes nor commutator are injured by the test.

The A.I.E.E. rules define successful commutation in nearly the same way, viz:

Successful commutation is attained if neither brushes nor commutator are burned or injured in an acceptance test or in normal service to the extent that abnormal maintenance is required. The presence of some visible sparking is not necessarily evidence of unsuccessful commutation.

Assuming that a machine is properly designed, the requirements outlined above should be met when the machine leaves the factory. If it does not, or if sparking (in the sense of destructive sparking) develops after use, the trouble is almost invariably in the condition of the commutator and brushes. Difficulties of this

kind should not be dealt with in a haphazard manner, but the possible causes should be analyzed, taking into consideration not only the present manifestations, but also the past history and the situation on similar machines under analogous conditions. Such abnormalities as overloads and grounds must, first be eliminated.

The most common cause of trouble in the past (and a not unusual one today) was high mica—a condition in which the insulating segments between the commutator bars protruded so that intimate contact was impossible. It was at one time thought that this was due to unequal wear as between the copper and the mica, but recent developments show that the real cause is electrolytic eating away of the copper.

Abrasive brushes are designed to keep the mica ground down flush, but frequently this is not the complete remedy. The eating away of the copper is roughly proportional to the current density, whereas the abrasive action is constant. Therefore, if the operating cycle includes long periods of light load, the wear on copper and mica will be fairly well equalized. But even when the evidences of distress are slight, commutator wear may be abnormal, increasing and decreasing as the mica becomes higher, or is worn down.

Electrolytic wear is greatest under the positive generator brushes, so that unless these are properly arranged circumferential grooves will be worn in the commutator. Fig. 2 shows the proper methods of staggering them.

Difficulty with high mica has been eliminated by the modern practice of slotting commutators. This permits the brushes to make intimate and uniform contact and reduces the wear, first, because softer, non-abrasive brushes may be used and, second, because it reduces materially the electrolytic action.

With a true and smooth commutator and brushes properly fitted in the holders so that they can move up and down without chattering, operation should be satisfactory within the limitations of the design of that particular machine, and it should commutate as well as the day it left the factory. If it does not, the following points should be checked:

(a) Brushes Not in the Commutating Zone—In a non-interpole machine this means, for a generator, a brush position somewhat forward from neutral. It may require some experimenting to find the point that gives the best average operation for all loads; possibly, too, no position is suitable for the entire range.

In compensated machines the brushes must be set exactly at the neutral point. Modern units are equipped with dowels and jigs at the factory, so that there should be no need of adjustment in the field.

If it becomes necessary to determine experimentally the neutral position, this can be done by either one of the following methods:

Standing or "Kick" Method—The brush arms should be checked to see that they are equidistantly placed about the commutator, and that the brushes line up exactly with the bars. All except two of the brushes (one in each of two brush-holders) should then be removed, and these should be sharpened to an approximate chisel shape so that contact is made with only one bar. To these two brushes a low-reading voltmeter should be attached—say one with 0-1.5 or 0-5 scale. The shunt field should be separately excited and a switch connected in the circuit.

Upon opening this switch the collapse of the magnetic field will induce a voltage in the armature conductors, the value of which can be read on the voltmeter. The brush rigging should be gradually shifted until a point of minimum voltage is found. In a symmetrical armature, and if there is a whole number of commutator segments per pole so that the pilot brushes are also symmetrically placed, this induced voltage will drop to almost zero when the pilot brushes are on neutral. Ordinarily, however, it is necessary to find an average by taking readings all around the commutator on different pairs of brush arms and using as neutral that point on which the arithmetical sum of the deflection is nearest zero.

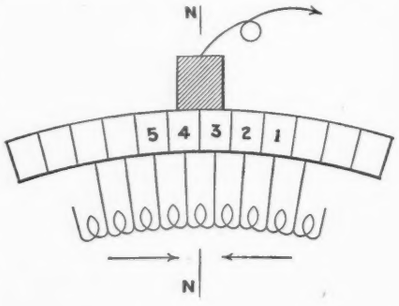


FIG. 1—IN THIS SIMPLE COMMUTATOR the current flow is toward the neutral zone, *N-N*, and out through bars *3* and *4*. The load current in the coil connected to bars *3* and *4* reverses as the bars pass under the brush and short circuit the coil.

* * * *

In making this test it will be noted that the closing of the circuit induces a "kick" in the opposite directon. Some testers prefer to take these readings, pointing out that the voltage due to the collapsing field is somewhat affected by the manner in which the switch is opened. In other words, a slow opening will give a different result than a quick break. There will always be an arc between the blade and the clip, and this may not always persist for the same length of time. On the other hand, the closing characteristics are subject to no variables.

Running Neutral—The brushes must be checked for spacing as before, and all removed except two chisel-shaped pilot brushes. These must, however, be sufficiently blunt to span the mica segments. The low-reading voltmeter is used as before. The interpoles are disconnected from the armature and separately excited from a source capable of supplying from *2* to 10 per cent of normal current. The shunt field is connected to a very low voltage.

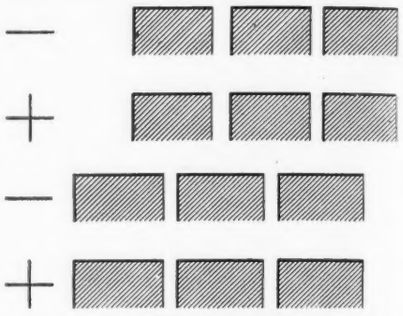


FIG. 2—TO PREVENT GROOVING of the commutator by electrolytic wear the brushes should be staggered as shown here.

* * * *

With the machine running at about full speed, and both interpole and shunt fields open, the voltmeter will read *2* or 3 volts due to residual magnetism. This is first destroyed by applying a feeble current to the shunt fields, first in one direction and then in the other. The interpoles are then excited to about *2* per cent of normal strength, and the brushes shifted until the armature voltage is zero. With the interpole unexcited, the residual magnetism should again be checked and reduced to zero if necessary.

These tests should be repeated with successively stronger interpoles, the point of zero armature voltage indicating the neutral brush position. Care should be taken to keep the residual magnetism at zero, but as the interpole current reaches higher values this will be difficult, and finally impossible. The test can, obviously, not be carried beyond this point.

(b) Brushes Improperly Spaced—The brush arms may be askew, i.e., not parallel with the commutator bars; or they may be unevenly spaced. This is best checked by means of a narrow strip of paper wrapped around the circumference of the commutator and marked against the toes of the brushes in the various arms. The paper is then removed and the spacing of the marks compared. The deviation should not exceed one-third of a bar.

On machines having an integral number of bars per pole, the spacing can be checked by counting the bars.

With modern machines trouble from this source is rare, for the

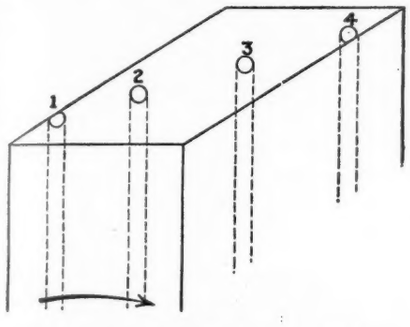


FIG. 3—TEST BRUSH for checking compensation. The brush is made of wood or fiber and holes are drilled in it as shown.

* * * *

brush arms and the various parts of the rigging are fitted and dowled at the factory.

(c) Unequal Current Distribution—Commutating difficulties are sometimes the result of unequal current distribution between studs, brushes, or parts of the brushes. This condition, in turn, may be caused by unsymmetrical design in the machine itself, or by inequalities in the brushes due to variations in composition, temperature, or contact resistance.

The most obvious cause of unsatisfactory current distribution is lack of uniformity in the brushes as regards resistance characteristics or contact pressure. The brushes of like polarity form parallel paths in a network of high conductivity; comparatively small differences will, therefore, have a considerable influence on the division of load.

There is usually no good reason why brushes of differing composition should be used on the same commutator. Sometimes attempts are made to obtain split-hair results by introducing such variations, but the benefits are in most cases exceedingly small.

There may be times when it is desirable to provide lubrication by using a few graphite brushes symmetrically distributed among the studs and arranged to cover the whole length of the commutator. Under some such conditions, best determined by experiment and observation, it is found advisable to remove the pigtails so that no load current will be carried; or, if necessary, the holders in which these brushes are placed can be insulated from the stud.

The variations due to unequal brush pressure can be eliminated by careful adjustment of the spring tension. This is sometimes done by means of a spring balance, and undoubtedly this method makes for accuracy. However, the available adjustments are limited to 4 or 5 steps and it is ordinarily possible to select the proper notch by the "feel" of the brush.

Conditions sometimes arise in which unequal current distribution is set up within the confines of an individual brush. This may be due to poor machine design, or to lack of uniformity in the composition of the brush. If the brushes pick up copper, low-resistance areas will be formed. Because of the negative temperature coefficient, the effect of this action is cumulative, and the ultimate result is the disintegration of the carbon due to the burning out of the binder material. This destructive action, called honey-combing, is hidden and often is not discovered until considerable damage has been done.

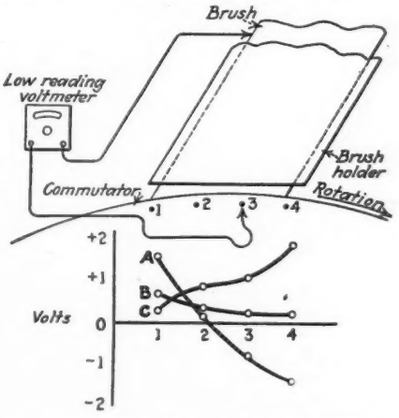


FIG. 4—METHOD OF CHECKING commutating pole field. The voltage is taken between the brush stud and a copper wire inserted in the different holes in turn. Curve *A* in the lower part of this diagram represents the results obtained on over-compensation, *B* correct compensation, and *C* under compensation.

* * * *

Brushes may pick up copper on a new or raw commutator—a condition that sometimes remedies itself—or that can readily be overcome by cleaning the brush faces after a short run. They may also pick up copper due to a type of electrolytic action; in such cases the brushes of only one polarity are so affected.

Honey-combing can sometimes be cured by increasing the brush pressure so as to secure more intimate contact over the entire face. If the machine is poorly compensated this remedy may, however, aggravate the difficulty, because the decrease in resistance permits a greater short-circuit current to flow. In that event relief may be obtained by changing to a brush of different composition, by slotting the commutator, or finally, by changing the characteristics of the machine.

(d) Improper Compensation—Improper compensation may, on a non-commutating-pole machine, be due to incorrect brush position, in which event the remedy is obvious. On an interpole generator it is to be expected that both the brush position and the strength of the compensating field were satisfactorily adjusted at the factory and there should be no occasion for any subsequent changes. However, if in the face of all other remedies, sparking persists, the interpole strength should be checked. This, fortunately, is not a very complicated process.

A fiber or wooden brush drilled as shown in Fig. 3 should be inserted in one of the brush-holders, and the voltage read between the brush stud and a copper wire feeler inserted into the holes in turn, the readings being designated 1, 2, 3 and 4, as shown. Fig. 4 shows the correct and incorrect brush curves, marked *A, B,* and *C*.

If it is found that the machine has improper compensation, the air gap must be changed by varying the shims under the feet of the interpoles. This is, however, a rather delicate operation, and it is usually advisable to call in a competent service engineer. If the machine is over-compensated, the interpole flux may be reduced by the use of shunts in a manner analogous to that used in adjusting the compound fields. These shunts must be wound inductively on a laminated iron core so that the current through them is properly proportioned, regardless of sudden load fluctuations.

Ring Fire—Ring fire is the common name for the commutator condition in which glowing particles of dirt between the bars create the optical illusion of incandescent lines, single or in bands, that completely encircle the commutator.

Ring fire is generally more spectac-

(Please turn to page 242)

INDUSTRIAL ENGINEERING
with which is consolidated
INDUSTRY ILLUSTRATED
Electrical, Mechanical and Plant Service in Industry
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New York, May, 1928

Encourage Suggestions from Within Your Plant

LACK of broad-minded visioned ability to recognize the value of the suggestion box in some industries is one of the short comings of operators and many other executives.

Men with ability and executive talent may be found in every plant who are certain to advance to positions where they can devote more time to mental effort, if they are given the proper stimulus and recognition for constructive thinking.

To substantiate the value of the suggestion box it is only necessary to relate that last year, one large progressive company made practically 5,000 awards for suggestions that came from within, tending to improve working conditions or increasing the efficiency of the company's operations. The fact that more than 32 per cent of the 15,000 suggestions received were accepted, and for which over $50,000 was paid in rewards, shows that it pays two ways.

The suggestion box encourages thinking, and that develops men who make industrial plants prosper and stay prosperous.

How Much Does It Cost Annually to Maintain A Motor?

A RECENT investigation by the Editors definitely proved that a great many, probably the big majority, of industrial plants do not know what their maintenance costs are. To be sure, there are available figures covering wage rates, with some general information on the cost of supplies, and that is about all. All too frequently, such cost and other figures as are available are scattered through a multitude of separate accounts; hence, the task of collecting them on one sheet of paper so that they can be analyzed is formidable.

Little argument is needed to show the value of accurate cost figures for maintenance, as well as production work. Obviously, without a definite knowledge of total costs, as well as the items included therein, any attempt to justify or reduce them must necessarily be largely guesswork. Again, in the absence of dependable figures, comparisons of the cost of maintaining different types of equipment and systems are impossible. Nor can the maintenance costs of one plant be compared with those of another, with any certainty that trustworthy conclusions can be drawn.

In all fairness it must be said that this condition is not entirely the fault of the maintenance executive; much of it rests with the accounting department. The head of the maintenance department is not supposed to be an expert accountant; nevertheless, he would be entirely within his rights in insisting that a system of cost-keeping be worked out that will show him the exact cost of doing every part of the work that falls to his department.

The Editors will be glad to hear from any readers who have developed cost systems that have taken maintenance work out of the "lump-sum" class and put it on a rational, business-like basis.

Obsolete Equipment Is Not Always Old

DURING the past few years much has been said about obsolete equipment, and the advisability, or necessity, of replacing it in order to increase production and cut operating and maintenance costs. In truth, there is a great deal of equipment in operation today that would be worth more to its owners on the scrap pile than in their plants. However, when we speak of obsolescense we usually have in mind equipment that was built ten or twenty or more years ago.

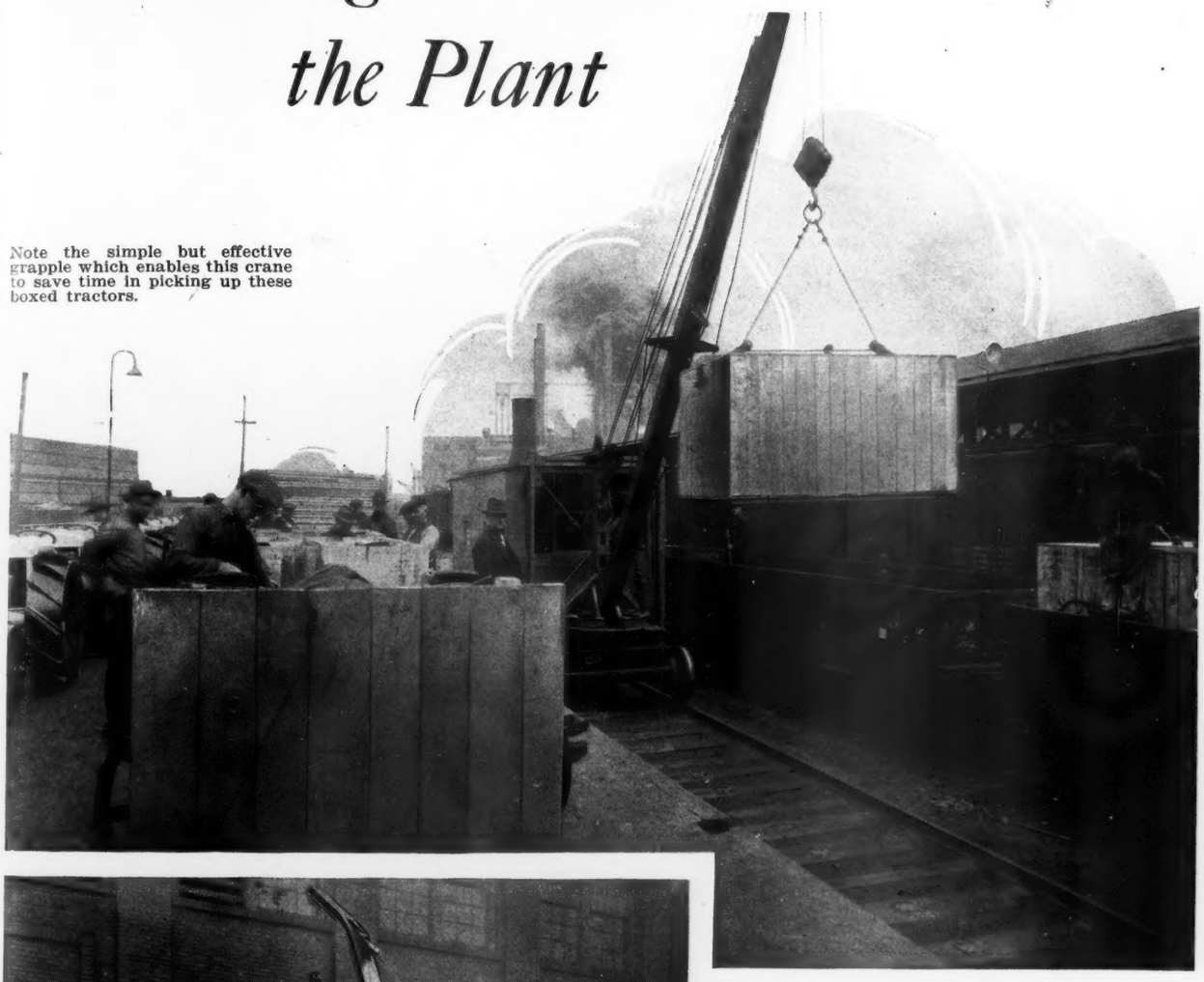
The fact of the matter is that age alone is not the only factor that determines obsolescense, in its broadest sense. Equipment that is new but does not embody the latest and best practices in its design, or that is not suited to the service so that it will perform in accordance with modern standards, is obsolete before it is installed.

For example, automatic or push-button control has fully demonstrated its worth in many different applications. To install manual control on such applications simply means putting in equipment that is already obsolete, even though it may represent the highest degree of skill in design and construction.

Again, anti-friction bearings have in many kinds of service shown their advantages conclusively enough to warrant installation, even in the face of higher initial cost. To put in sleeve bearings where the anti-friction type would be justified, or dictated by good practice, is merely another instance of installing new, but obsolete, equipment. Many examples of this sort could be given.

From the narrow standpoint of price there may be some excuse for purchasing such equipment. Nevertheless, it is practically certain that this slight advantage will be swallowed up many times during the life of the device by the lower efficiency and higher operating and maintenance costs.

Quicker Ways of Doing Things Around the Plant



Note the simple but effective grapple which enables this crane to save time in picking up these boxed tractors.

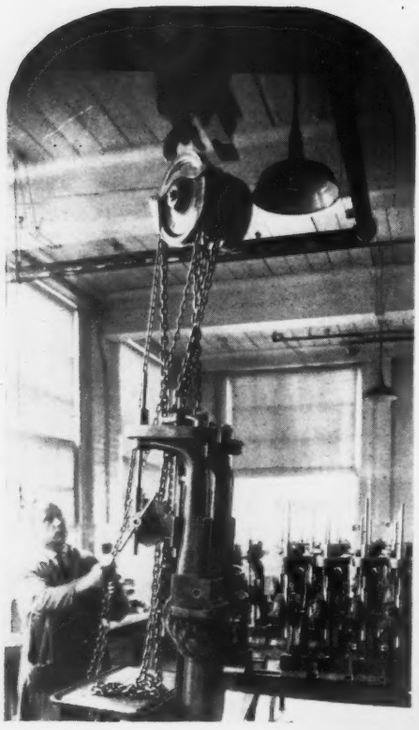
Not restricted to tracks, this crane-equipped industrial truck works both inside and outside the shop. Here, it is saving some time for its big brother, the motor truck.

THERE are almost as many ways of doing things as there are men to decide how they shall be done. This applies especially to the wide variety of jobs which come under the general classification of materials handling.

When it comes to lifting, moving or handling, speed is the important consideration; for the time spent on such jobs is non-productive time and adds nothing to the value of the product.

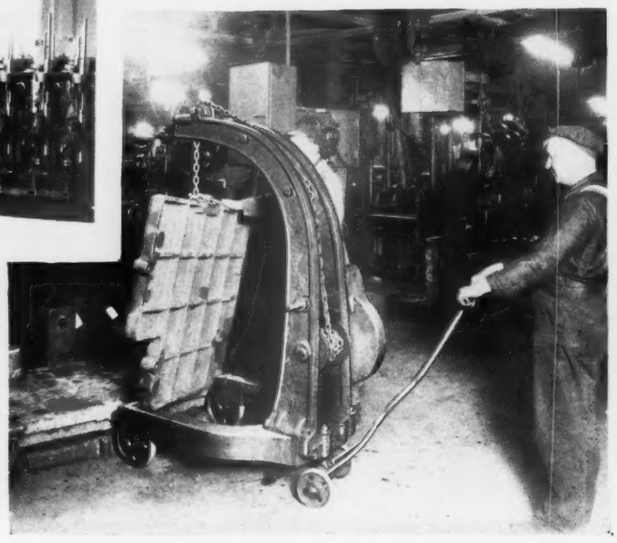
On these pages are shown a few time-saving ways of handling these jobs—methods that might be profitably applied to some of your own problems.

Quicker Ways of Doing T

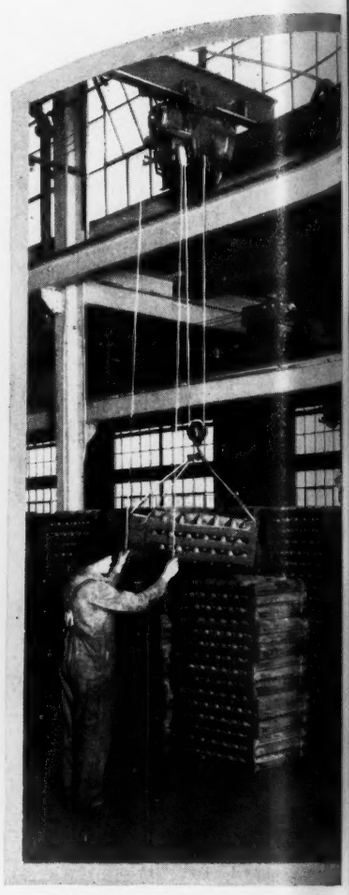


The chain hoist offers one way of speeding up the moving of production machinery; either by overhead trolley or in combination with a lift truck.

These heater sections, in the illustration at the right, are easily picked up for a quick trip to destination. Note the simple rig which saves time in picking up and letting go.



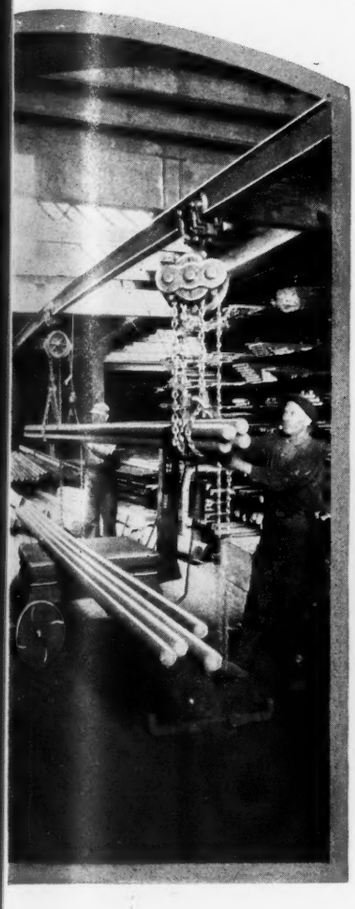
A hand operated device that speeds up and simplifies the handling of heavy, bulky castings and saves labor besides.



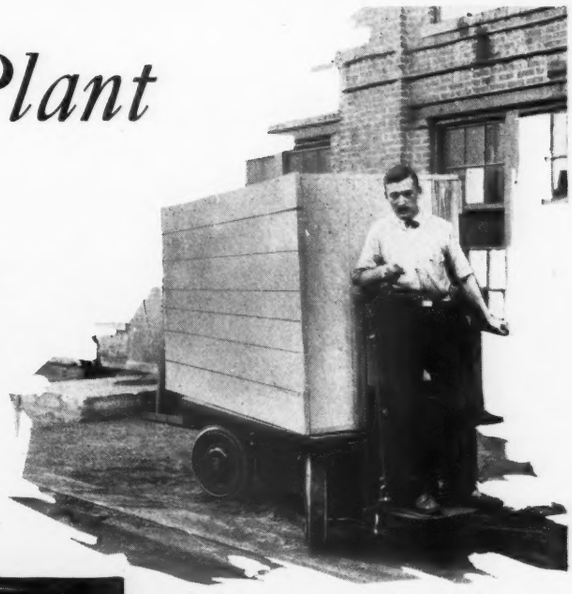
Handling bar stock to and from storage. This is one way of speeding it up; a different method is shown in an other illustration.

The hand lift truck enables these two men to transport one-third more of these valve bodies, while the platform skid system saves loading and rehandling time.

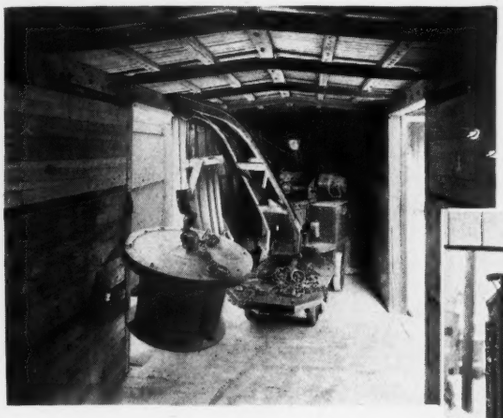
Things Around the Plant



The chain hoists and I-beam shown at the left handle just four times the load of bar stock that the two men could handle alone; thereby doing the job in one-fourth the time.

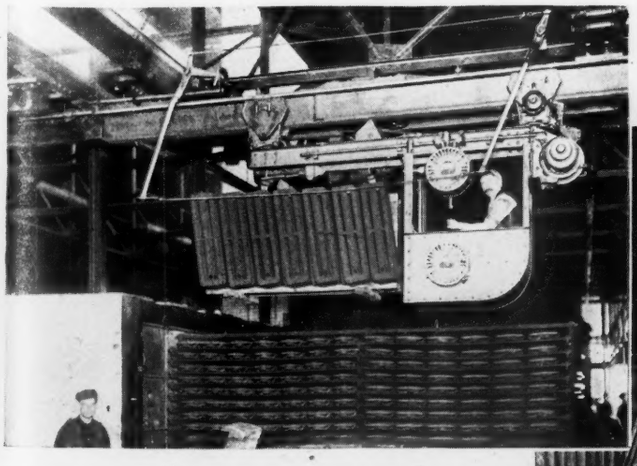


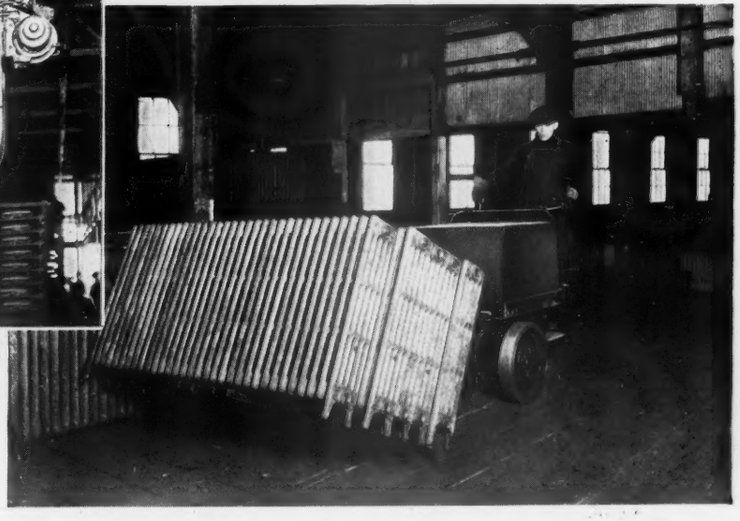
Contrast this method of speeding the handling of heavy cases with the two shown on the opening page. Yet in spite of the variety of better ways available, too many plants still rely on man-power.



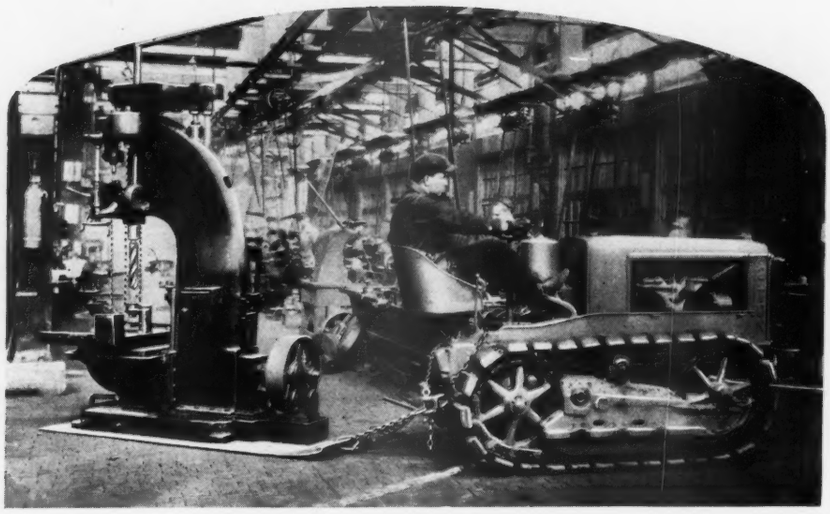
One man is doing a job, here, which without the crane-equipped truck, would require from three to five men and more than twice as much time.

Handling these bags of iron castings used to be a slow, back-breaking job; until somebody saw the tremendous time-saving possibilities of the electro-magnet.





The monorail hoist, above, solves the problem of speeding up the work under the particular conditions involved, while at the right we have a lift truck doing the same kind of job.

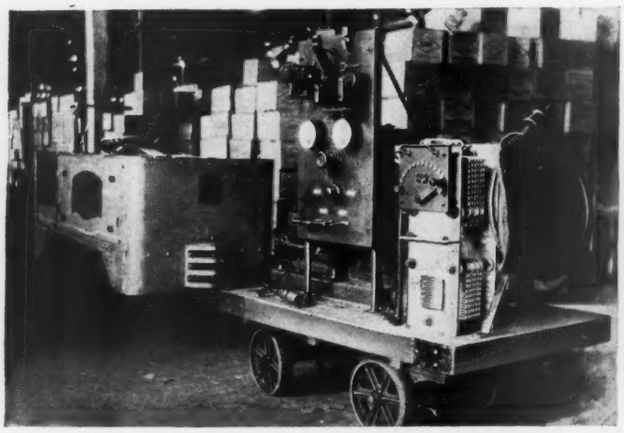


The gasoline tractor, plus a little ingenuity, makes light of the job of moving heavy machinery to a new location. Remember the crew of men with crowbars and rollers or short lengths of pipe?

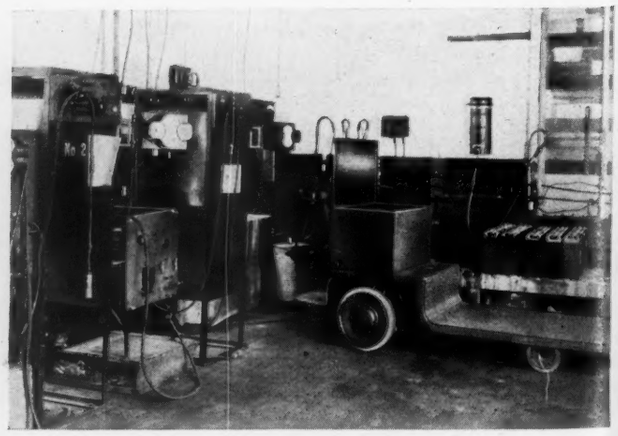
Quicker Ways of Doing Things Around the Plant

Handling stacks of paper or cardboard by means of a fork-equipped high-lift truck; one way of speeding up the job, though by no means the only way.

The hand-operated lift truck and skid system originated in this type of work; having been developed to meet the need for greater speed and flexibility in handling stacked paper.



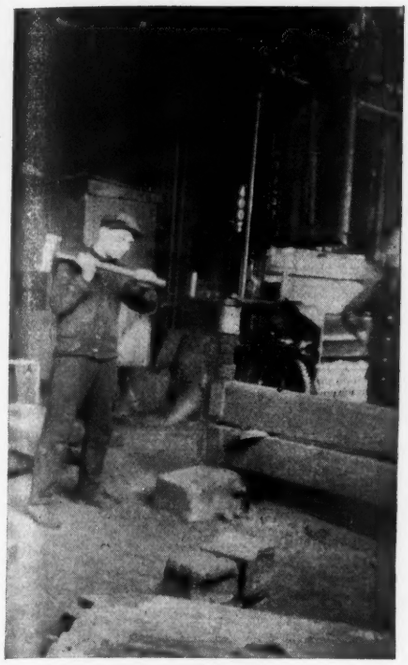
When Mahomet finds it difficult to go to the mountain, the mountain can be brought to Mahomet, to save time. A portable charging station for electric trucks, which brings service to any part of the plant.



Charging and service room for electric storage battery trucks. Power-operated equipment, whether gasoline, electric or steam, "eats" only when it works, and is always cheaper and quicker than human muscle.

Checking the Welders

by Procedure Control Methods



By H. E. ROCKEFELLER

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This is the first article of a series on pressure vessel welding in which the author discusses the selection of a satisfactory welding personnel. Other articles dealing with the selection of material, design of the vessel and welded joints, preparation of material, welding technique and tests on the completed vessel will appear in sequence in early issues.

DURING the World War such enormous savings were effected in reclamation and production applications, that there seemed scarcely a place where welding could not be used in joining metals or reclaiming defective material. This growth has continued, until today, less than a decade since the termination of the war, it is rare that one encounters a shopman or engineer who has not become acquainted with the oxy-acetylene process either through actual use or observation.

This acquaintance, unfortunately, has not always ripened into true friendship. The apparent simplicity and consequent lack of appreciation of a thorough understanding of welding, has, in some cases, resulted in failure to live up to the expectations of the user and, therefore, mistrust in the process. The realization by many, however, that uniformly successful results in welding can, and are, being obtained, has led to the adoption of the phrase, "Procedure Control." This term has come to mean to welding what standardization and scientific management mean to industry in general. For any welding application, Procedure Control implies an understanding of all the factors involved and a consequent pursuit of certain known and desired results.

These factors as we have determined them for pressure vessel welding include:

(*a*) Checking the welders, which embodies the selection of a satisfactory welding personnel.

(*b*) Selection of material, which has to do with the base material as well as the welding rod and the proper welding equipment.

(*c*) Design of the vessel and welded joints. In this division is included the selection of the most satisfactory joints for welding as well as the design of other parts which may be effected by the welding or the tests on the completed unit.

(*d*) Preparation of material, which includes the necessary jigs, spacing, alignment, etc.

(*e*) Welding technique, under which is included the necessary provisions for insuring proper deposition of the weld metal, preheating of certain parts, etc.

(*f*) Tests on the completed vessel. Under this heading are incorporated the necessary tests to insure the acceptability of the vessel and its safety under operating conditions.

Through Procedure Control, the responsibility for the success or failure of the process is not placed entirely upon the shoulders of the welder as often has been the case in the past. The welder, in procedure control applications of welding on the other hand occupies the same relative responsibility as the riveter, tool maker or any other skilled mechanic. His responsibility is confined to the proper technique of depositing weld metal. Thus, the responsibility for selecting the proper material, properly designing the welded joints, procuring proper inspection and tests, etc., rests, as it should, with the management.

That procedure control methods can be successfully applied is attested to by the very rapid growth of pressure vessel welding during the past three years and the extremely successful results which have been obtained where procedure control methods have been followed. During this interval, over 200 vessels, ranging in diameter from 4 to 7½ ft., up to 90 ft. in length, and with operating pressures as high as 300 lbs. per sq.in. have been constructed under our supervision. The designed operating fibre stresses in these vessels, fur-

thermore, for the most part are greater than those usually employed in other forms of pressure vessel construction. These vessels include storage tanks for high pressure gases, condensers, creosoting tanks, kilns, autoclaves, kettles, and various other equipment requiring for their operation, permanent leak-proof joints.

Because of the high stresses to which the welds in pressure vessels are subjected and because of the many varied problems encountered in this field of application, pressure vessel welding furnishes an excellent subject for the discussion of the factors involved in procedure control welding.

In succeeding articles, a detailed consideration of the other factors will be given and taken together, will furnish a complete general picture on procedure control welding.

In providing for a check of the welder's ability and the limitation of his responsibility, Procedure Control has done away with one of the greatest evils which was a natural result of the extremely rapid initial growth of oxy-acetylene welding. Not so many years ago, a welder was considered by many as a sort of special and independent being. Provided he could convince the management that he had had a sufficient number of years experience as a "welder," his word on all matters pertaining to welding was taken as law. This condition was prevalent because of the gross lack of knowledge on the part of the management concerning the fundamentals of welding and their inability to know, whether a welder was qualified to pass judgment upon the weldability of a certain material or design, or even to deposit the weld metal properly.

This condition certainly rarely exists today, but even where the management has assumed the responsibility for all the factors involved in welding, except for the actual deposition of the weld metal, there still seems to be considerable concern over the human element in weld metal deposition.

To those who have seen any amount of welding done by operators who are qualified to carry out the particular job under consideration, the human element becomes an exploded myth. Trouble does creep in, however, when a welder is asked to do something he is not qualified to do. Very few, I believe, would ask a welder whose experience has been confined to cast iron, to weld on steel piping or pressure vessels, without first qualifying for these latter applications. Many others perhaps would hesitate in putting a welder to work on steel-plate pressure vessel work whose experience had been confined to steel piping. How many, however, would require a welder experienced in welding $\frac{3}{8}$-in. steel-plate pressure vessels, to qualify for welding $\frac{3}{4}$-in. plate on this application? And yet our experience has shown that the last mentioned qualification test is just as important as the other two. In other words, there is enough difference in welding between $\frac{3}{8}$-in. and $\frac{3}{4}$-in. plate to make possible a successful application in the first instance and a failure in the second if the welder has qualified only on the lighter plate.

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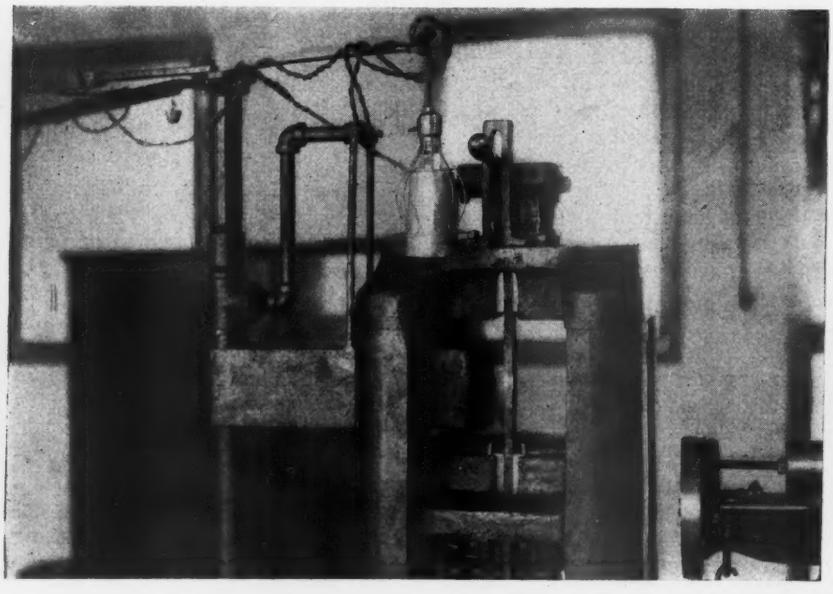
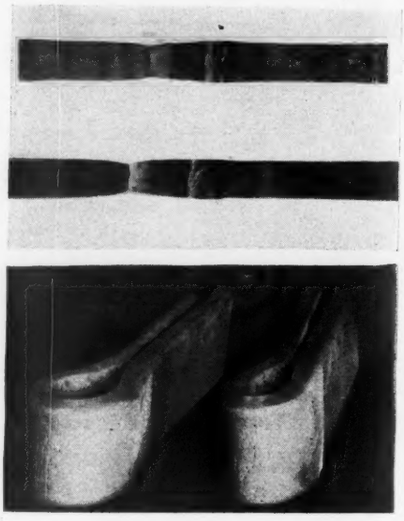
A WELDED COUPON being subjected to tensile test. The results of laboratory tests are shown in the table.



Any qualification test should approximate as closely as possible the actual conditions under which the welding is to be done. Some shops have considered it satisfactory to qualify a man merely on his previous experience; others have permitted men to become considered as full-fledged welders after they have had a certain training period as helpers. A visual inspection of the manner in which the applicant deposits his weld metal has also been used as a means of qualification. Although any of these methods may give good results, they are too uncertain to be considered satisfactory for procedure control practices. Therefore, before we will permit any operator to weld on pressure vessels, we must be assured both that his experience is satisfactory and that he can successfully pass a qualitative test which always includes a tensile test of a welded coupon and sometimes also, a bending test.



TYPICAL RESULTS of tensile tests of welded coupons are shown in the upper illustration. The lower view shows two welded specimens which have been bent double without signs of fracture.

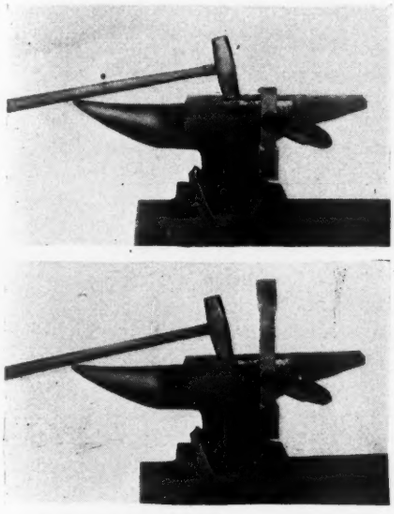
* * * *

The justification of the requirement of a qualitative tensile test has often been brought to our attention in qualifying welders under procedure control methods. In some instances, welders who have had over ten years experience in a single shop and who are considered by the management as the best men in their profession, are incapable of passing tensile test requirements on first trial. These men usually are astounded when shown the results of the tensile tests and the defects in their specimens. Knowing the reasons for these defects after having seen them, they can correct

their mistakes and produce a satisfactory test specimen.

In another instance where applicants were being considered for a large pressure vessel construction program, 27 welders were tested out before four men could be secured who were sufficiently proficient on the thickness and type of welding required for this work.

In determining upon the qualification coupon for tensile test, the design of the weld material, welding rod and thickness of the plate should



WELDED SPECIMEN set up preparatory to making preliminary bend tests. The lower view shows the same specimen after having been bent through an angle of 90 deg.

* * * *

be the same as that for the pressure vessel under consideration. The length of the required test weld, furthermore, should be sufficient to eliminate the possibility of the applicant exercising different technique than would be employed in production. The method of welding should also be the same as called for on the construction under consideration.

The following specification has been employed by us for sometime covering the qualification test for welders on pressure vessels.

Test Specimens—Unless approval has previously been given by the buyer or buyer's representative on each operator for the type of welding and thickness of material involved, qualification test specimens shall be submitted by each operator and forwarded to an approved testing laboratory.

These specimens shall be made from two plates of a thickness not less than the shell thickness involved, each plate being 9 x 12 in. The 12-in. edges being designed, prepared and welded in accordance with the drawings as shown in the accompanying illustration.

Laboratory Test—Five* standard A.S.M.E. Coupons shall be cut from the specimen and submitted to tensile test, three of these coupons having the weld reinforcement removed before testing.

No operator shall be permitted to weld on the vessel or vessels included in the order until approval has been given by the buyer or buyer's representative, this approval being contingent upon each coupon having a minimum ultimate strength of 50,000 lbs. per sq.in.** an average of 52,000 lbs. per sq.in. and all weld fractures, if such occur, being free from any appreciable defects.

The tables shown comprises portions of two laboratory reports, one giving the results of tests on $\frac{3}{8}$-in. and $\frac{5}{8}$-in. material and the other on $1\frac{1}{4}$-in. material. These reports are entirely representative of the results which can be expected where Procedure Control methods have been established and where instruction has been given to overcome defects encountered in initial trials.

Two methods may be used to establish a welding personnel capable of giving results similar to the above. The welding organization may either be built up through the employment of trained welders from the outside or by training men from within the organization. In the first instance, the men are first interviewed to determine if their previous experience is of the type required. If so, they are permitted to weld a preliminary test specimen similar in size and design to the final tensile test specimen mentioned above. The welding of this specimen is usually observed by the welding foreman or inspector but the applicant is permitted to select his desired size of welding tip, pressures, method of welding, etc.

After this test specimen has been welded, it is cut into strips about 2 in. in width, the cutting being done with an ordinary oxy-acetylene cutting blowpipe.

These strips are then subjected to test by placing them in a vise, with the edge of the weld flush with the vise jaws and bending them with a sledge. Each specimen should, if satisfactory, bend through an angle of at least 90 deg. It is the usual practice to bend at least one of the specimens double on itself. The others are bent forward and backward until fracture through the weld occurs. Examination of the fracture will give a good indication of the ability of the welder and can be used to determine whether or not he shall be permitted to make up a specimen for tensile test.

Many applicants will show their utter inability to meet the requirements of the work on their preliminary test. Others may show promise and these are usually given a second

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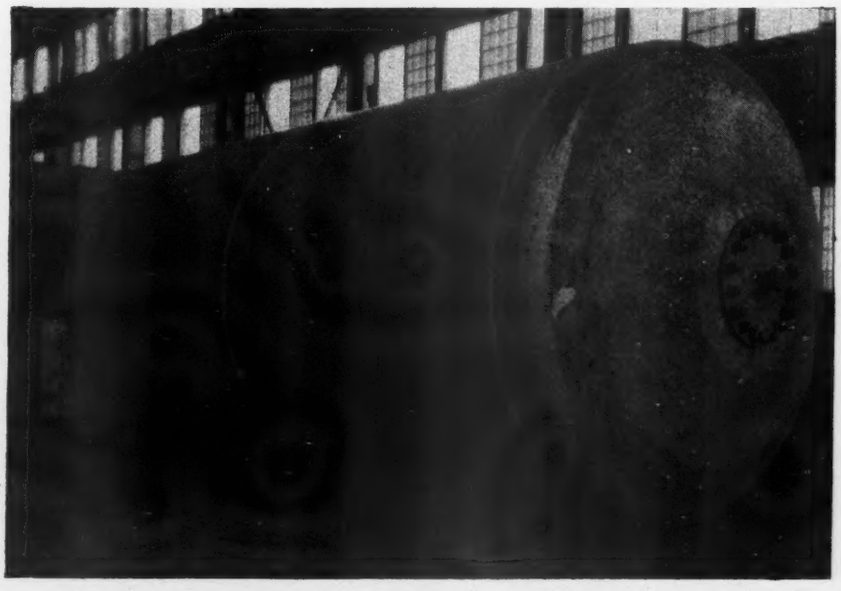
A TYPICAL VESSEL oxy-acetylene welded in accordance with Procedure Control methods.



*Provided each of the three coupons with reinforcement removed, exhibit an ultimate strength in excess of 52,000 lbs. per sq.in., the remaining coupons need not be tested.

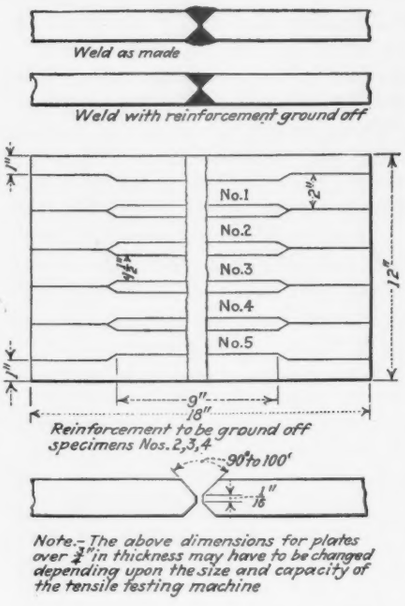
**Coupons which break in the plate at an ultimate strength of 48,000 lbs. per sq. in. minimum shall be considered acceptable. Any specimens, furthermore, which break in the plate at an ultimate strength of less than 52,000 lbs. per sq.in. shall not be taken into account in determining the average strength of the speciments tested.

trial after their defects have been pointed out. Still others may indicate their ability on the first test to do the work satisfactorily and these are permitted immediately to make up their tensile test specimens. The results of the tensile tests, in every instance, determine whether or not an applicant shall be accepted for welding on the application under consideration.

In the case where men are trained from within the organization, they usually spend a certain training period during which they act as helpers for the qualified welders, assisting in spacing the seams, keeping the work in proper alignment, changing cylinders, charging the acetylene generators, etc. In this way they become acquainted with the general technique of welding and learn to recognize the manner in which weld metal is properly deposited. During this interval, they are given opportunities to make up trial welds, first on light material and later, on the heavier thicknesses. On these trial welds an effort is made first to secure complete penetration and fusion and then to obtain an appearance and contour of weld which is satisfactory. The specimens are cut up and fractured through the weld by bending the defects and methods for overcoming them being pointed out by the welding foreman.

When the helper has gained sufficient experience and training he is permitted to make up a tensile test specimen which, if satisfactory, permits him to weld on the thickness for which the specimen was submitted.

Newly accepted welders are usually given the more simple seams to weld,



PREPARING TEST COUPONS. The dimensions of the welded specimens used in the tests. The results are shown in the table below.

* * * *

that is, where no preheating is required or where expansion and contraction difficulties are least likely to be encountered. As their experience with the actual construction work increases, they are permitted to weld on the more difficult seams.

In comparing the two above described methods, we have found the latter to be the better, particularly when one or two experienced and qualified welders may be used as a nucleus. In the first place, the supposedly wide and varied experience claimed by the type of welder who drifts from one shop to another on different classes of welding, is of little use on pressure vessels and often in fact, is a handicap. A man who has been trained by competent welders on one class of welding, moreover, is likely to be a more permanent and reliable addition to the welding personnel.

Defective Commutation

(*Continued from page 233*)

ular than dangerous, although it may be a warning of the deterioration of the mica. On new machines it is often caused by foreign substances, such as varnish, carbon particles from the newly-sanded brushes, or dirt from the hands. This dirty deposit can be wiped off (after shutdown) with gasoline, observing, of course, the usual precautions against fire.

Flashovers—The most severe commutating disturbances are flashovers between studs or to the frame. These may do considerable damage and in any event require a shutdown and an inspection.

Flashovers are due to the breaking down of the air insulation between bars, through causes that at times are rather obscure. The arc is progressive, starting between two bars and spreading with great rapidity over the whole distance. The high voltage is generally ascribed to abnormal distortions in the field form, due to sudden load changes and the consequent upsetting of the equilibrium between the various component fluxes. Any undue tendency to flash over indicates a faulty design, although complete immunity cannot be obtained except by the use of elaborate auxiliary protective devices.

RESULTS OF LABORATORY TENSILE TESTS ON WELDED QUALIFICATION TEST COUPONS

Specimen No.	Size Inch	Pounds per Sq. In.		Per Cent Elongation in 2 In.	Fracture
		Yield Point	Tensile Strength		
202–1	¾	45,605	66,700	....	2 in. from weld.
2G		42,400	64,000	....	1½ in. from weld
3		43,900	66,500	....	2½ in. from weld
4G		43,000	63,250	....	2 in. from weld
5		42,900	66,200	....	1 in. from weld
263–1	¾	38,000	64,800	....	3 in. from weld
2G		38,800	63,100	....	2 in. from weld
3		38,700	63,600	....	2 in. from weld
4G		37,000	61,750	....	4 in. from weld
5		37,300	62,900	....	2½ in. from weld
J-G*	1.270 x 0.780	33,400	55,000	5.0	Plate
J-G*	1.265 x 0.950	.....	55,300	11.5	Plate adjacent to weld
J-G*	1.240 x 0.830	32,400	53,600	10.0	Plate adjacent to weld
V-R†	1.240 x 0.800	32,700	58,200	4.5	Plate
V-R†	1.240 x 0.760	33,800	55,750	3.5	Plate
V-R†	1.240 x 0.900	31,100	57,200	4.0	Plate
N-G‡	1.260 x 0.905	32,100	54,700	14.0	Weld and scarf —Poor fusion at outside edge of scarf
N-G‡	1.210 x 0.830	33,500	37,800	7.0	Weld and scarf —Poor fusion at outside edge of scarf
N-G‡	1.275 x 0.775	33,800	57,700	15.0	Plate adjacent to weld
NC-1	0.915 x 1.250	34,300	57,300	4.0	Edge of weld (Broke in weld)
2G	1.075 x 1.275	33,800	56,100	6.5	1 in. from weld
3	0.950 x 1.250	34,800	69,900	4.0	2 in. from weld
4G	1.025 x 1.285	35,400	60,500	8.5	Part plate and part weld

*G = with reinforcement ground off.
†R = with reinforcement not removed.
‡Welder "N" failed to meet qualification test on this trial and submitted another specimen which is indicated as "NC" above.

Fig. 1—An apron conveyor, at the left, and a belt conveyor are handling coarse and fine ore.

Fitting the Conveyor to the Job

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THE PROPER type of conveyor to use for any particular application is usually determined by the kind of material carried, method of dumping, space limitations, and whether the material is to be carried horizontally, vertically, or on an incline.

In order to facilitate the intelligent selection of this equipment, a brief description of the common type of conveyors and their field of usefulness, will be given. The types of motors and control equipment adapted to such service will be discussed in a succeeding article.

Apron Conveyor—The apron conveyor, one of which is shown in Fig. 1, consists of a series of flat wooden slabs or steel plates, sometimes called "flights," which convey material either on a horizontal plane or on an incline. In the case of an apron conveyor with steel plates or flights, the latter are usually provided with a double bead so that they always overlap and make a tight apron. When required for carrying loose bulk material, the flights are provided with sides so as to make a moving trough.

Wooden apron conveyors are usually of one general type consisting of a series of wood slats carried at both ends on endless steel or malleable-iron chains.

Steel apron conveyors are used for conveying and feeding loose lump and granular material, such as coal, sand, rock, and ore. Without sides and in the form of flat-top conveyors they are used for carrying billets, plates, castings, machines and machine parts, and miscellaneous articles of practically every description, particularly articles that are too heavy for loading onto a belt conveyor. Operating at slow speed, steel apron conveyors are used for continuous molding and pouring, continuous assembling, for drying, roasting and cooling, for annealing, heat-treating and tempering, for slushing and dipping parts, and so on. Another wide use is as sorting tables principally for coal, but also for fruits, vegetables, garbage and refuse. They are also used as inspection tables for both manufactured articles and food products. Speeds of steel apron conveyors vary according to the work to be done, about as follows:

When used as feeders	10-30 f.p.m.
Picking tables	50 f.p.m.
Carrying sand	30 f.p.m.
Carrying lump material, such as coal, stone, coke, or ore	60 f.p.m.

Wood apron conveyors are principally used for carrying boxes, bags, packages, baggage, barrels, castings, tires, machines in course of assembly, and manufactured articles of various kinds.

In general, the apron conveyor has the following advantages:

1. Can be used on either a horizontal or inclined plane.
2. Can handle bulky articles, such as packages, boxes, bales and bags.
3. Wooden apron conveyors can handle cylindrical objects, such as barrels or kegs, up steep inclines when proper cleats are used on the aprons.
4. Can handle lumpy material, such as run-of-mine coal or rock, as well as small sizes of coal, sand, gravel, crushed rock, ores, ashes, etc.
5. Malleable-iron apron conveyors are particularly suitable for handling hot ashes and similar materials.

Belt Conveyors—Belt conveyors, see Figs. 2 and 3, are by far the most universally used of all types. Gritty material that causes excessive wear on scraper conveyors is best handled by belt conveyors. On the other hand, hot cinders or wet ashes cause belts to deteriorate rapidly and are best handled by bucket conveyors. Also, packages that are too heavy for belts are best transported by apron conveyors. The simplest form of belt conveyor consists of two pulleys, a belt, and idlers for supporting the belt. The lower idlers are always flat faced, but the upper idlers may be either flat faced or troughed.

* * * *

FIG. 2—THIS BELT CONVEYOR, which is 246 ft. long and 30 in. wide, handles mail sacks in the Northwestern Depot sub postal station, Chicago, Ill. The empty sacks are brought back by the lower or return belt, which discharges them by means of a fixed tripper.

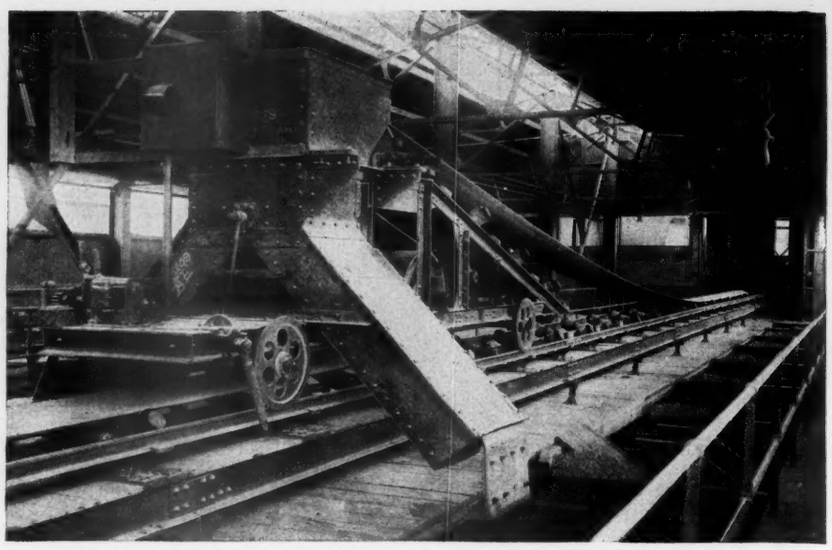

FIG. 3—A BELT CONVEYOR used for handling ore in the plant of a mining company. A movable tripper is employed for discharging ore into any desired bin.

* * * *

The principal uses and characteristics of a belt conveyor are:

1. Adapts itself to the handling of material of widely differing characteristics, such as grain, sand, ores, chemicals, rock, coal, packages, bags, boxes, paper and mail bags.
2. It is the simplest of all conveyors. Wear and upkeep are small.
3. The power required is less than for any other type of power-driven conveyor.
4. It requires little headroom.
5. Quiet in operation.
6. Light in weight.

A belt conveyor has its limitations, which are mainly as follows:

1. It cannot handle material that comes in large and exceedingly heavy pieces because the impact of such pieces, when loading the belt, will cause excessive wear.
2. It is not suited for handling hot materials, as the heat causes shrinkage and rapid deterioration of the belt.
3. When used for elevating as well as conveying it is limited to a maximum angle of approximately 20 deg.

The maximum speed of a belt for conveying loose material is approximately 250 f.p.m. for a 10-in. belt, to which may be added 10 f.p.m. for each additional inch of belt width. A good average speed for troughed conveyors is between 250 and 400 f.p.m., depending on the width of the belt. Non-abrasive granular material, such as grain, can be economically conveyed between 400 and 600 f.p.m. Flat conveyors carrying packages or miscellaneous articles operate best at about 100 f.p.m.

Bucket Conveyor—A pivoted bucket conveyor consists of buckets or pans hung between two lines of chain that run on large rollers. The pivoting of the buckets makes it possible for material to be carried horizontally, vertically, or on an incline without spilling. This type of conveyor has come into general use in boiler plants for the combined elevating and conveying of coal, and is adapted to carrying ashes, pebble phosphate, hot cement, clinker, and small-size ores. The usual capacities vary from approximately 40 to 200 tons per hour. The advantages of the pivoted bucket conveyor are:

1. It is quiet in operation.
2. It conveys and elevates at the same time and avoids transfer of material, which is often troublesome, requiring deep pits and valuable space.
3. Power consumption is low.
4. Low cost of maintenance.
5. Handles ashes, red hot or dripping

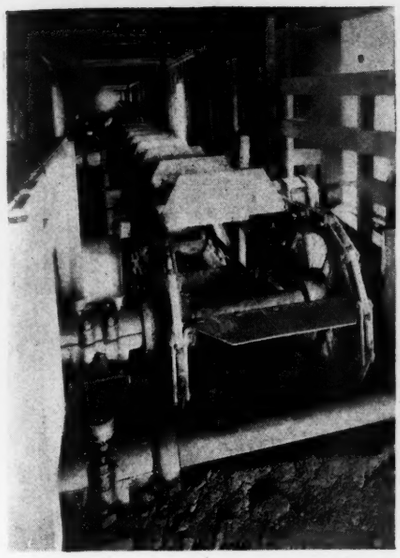

FIG. 4—THIS SCRAPER CONVEYOR is 140 ft. long and is fitted with 20-in. x 7-in. steel "flights." The conveyor operates at 100 f.p.m. and loads coal bins at the rate of 50 tons an hour.

* * * *

wet, and other hot or corrosive material, a duty that will damage most other forms of conveyors.

6. Adapted for dumping at various points.

The main disadvantages of a pivoted bucket conveyor are:

1. It cannot be fed on a vertical run, and will not pick up its load under a turn wheel; it must always be fed on a horizontal run.
2. It must always have a horizontal run at the discharge.
3. This equipment is relatively high in first cost.

The speed of this type of conveyor is limited to around 40 to 60 f.p.m., due to the method of dumping, which consists of the tilting of the individual buckets when they arrive at the dumping place. The shock of tilting the buckets limits the speed.

The height to which it elevates material is usually limited to around 70 or 80 ft. As usually built, the bearing value of the pins does not permit of lifting to greater heights.

Shaking Conveyor—This type consists of a metal trough supported on rollers. By means of an air or electric motor the trough is gently moved ahead a short distance and then slightly dropped and returned to the original position so quickly that inertia keeps the material in the advanced position. This reciprocating motion of the conveyor trough is rapidly repeated and the coal or other material moves along in the trough. This is a comparatively new type of conveyor in this country and the advantage claimed for it is its value in thin coal seams having scant headroom. It can also easily be lengthened or shortened by adding or removing trough sections, and can transport material on the level or up grade, providing the grade does not exceed 15 deg.

Scraper Conveyor—This conveyor, sometimes called a flight conveyor, consists of a series of plates or flights supported between two parallel chains as will be seen in Fig. 4. It operates by scraping the material along in a trough.

It is extensively used for conveying pulp logs in the paper industry, coal in power houses, coal pockets and storage plants, for conveying and retarding coal in tipples, washers and breakers, for carrying garbage and tankage in reduction plants, for carrying hot clinkers from cement kilns to coolers, and for conveying sawdust and chips in saw mills and woodworking plants. Such conveyors also find wide use in carrying chemicals, fertilizers and many other non-abrasive materials. The average speed is around 60 f.p.m. When used to convey lump coal from hoppers the operating speed is about 20 f.p.m. For carrying ashes a speed of 5 to 10 f.p.m. is used. Material can also be elevated on an incline of 30 to 45 deg. from the horizontal. Capacities range from 5 tons to 250 tons per hour.

The drag conveyor, which is the simplest form of scraper conveyor, has the particular advantage of being the simplest and least expensive of all conveyors. It is also compact and lends itself to use in congested conditions where space is limited. The flight conveyor is more elaborate in construction than the drag type and consequently more expensive; it also requires more room. Both types require relatively more power to drive than other types, due to friction losses

FIG. 5—A SCREW CONVEYOR 58 ft. long and 12 in. in diameter, handling fine coal in a boiler house. This type of conveyor is used chiefly for horizontal conveying of small-size materials.

* * * *

attendant on their mode of conveying material. They can be loaded at as many points as may be necessary, and can be discharged at any point desired.

In the case of the drag chain the material must be small enough to go through the space between the side bars of the chain; otherwise it can be discharged only over the headwheel. Another simple form of this type of conveyor consists of a wire rope with split buttons bolted on at intervals, as are used for handling pulp wood.

Screw Conveyor—This type of conveyor, shown in Fig. 5, consists of a helical steel ribbon encircling a central shaft and encased in a cylindrical or semi-cylindrical casing. Rotating the shaft causes the material to be pushed along inside the cylinder by the helical ribbon.

Helicoid screw conveyors usually handle various materials at the following speeds:

Grain	160 to 200 r.p.m.
Sand, gravel, ashes (dry and containing no large lumps or stones)	80 to 125 r.p.m.
Coal (screenings, or small-sized coal, no lumps larger than 1 in.)	80 to 110 r.p.m.
Cement	85 to 125 r.p.m.

The screw conveyor has the following advantages:

1. It is low in first cost.
2. Requires little headroom.
3. It is simple in construction.

Its disadvantages are, mainly:

1. The power consumption is high.
2. Its use is limited to conveying small-sized materials for short distances.
3. Wear is rapid, particularly when handling abrasive materials.

How Magnetic Brakes

relieve the strain of quick stopping

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CONSIDERABLE energy is stored in the various rotating members of certain machines containing rolls, cylinders and drums which, when stopped quickly, produce extremely high stresses in the driving members if retarded only by a braking effort at the point where the power is transmitted, such as the motor drive of a modern newspaper printing press.

Considering that the acceleration period is six to eight times greater than the decelerating, or stopping time, the stresses in the various driving members such as gears, jaw-clutch couplings and shafts, are many times greater than those resulting from the normal driving torque, and in a reverse direction. On newspaper presses with the printing cylinders operating at about 250 r.p.m., corresponding to 30,000 papers an hour and using a 60- to 100-hp. motor drive, the stopping is accomplished by dynamic braking on d.c. equipment and by means of a magnetically operated brake on a.c. equipment at the motor drive.

The new modern super-speed presses, that print from 40,000 to 60,000 papers an hour, use solid steel cylinders to which the printing plates are fastened; these revolve from 333 to 500 r.p.m. and use larger driving motors ranging from 150 to 250 hp. The weight of one of these printing cylinders varies between 3,500 to 4,000 lb. There are four cylinders to one printing press unit for printing sixteen pages of newsprint. For newspapers with a larger number of pages, four, five and six press units are driven from one motor drive equipment.

The energy stored in the revolving cylinders of a single press unit printing 48,000 papers an hour, is about 83,000 ft.-lb. Considering four press units, printing 40-page newspapers at a speed of 48,000 an hour, the stored energy is approximately 332,000 ft.-lb.

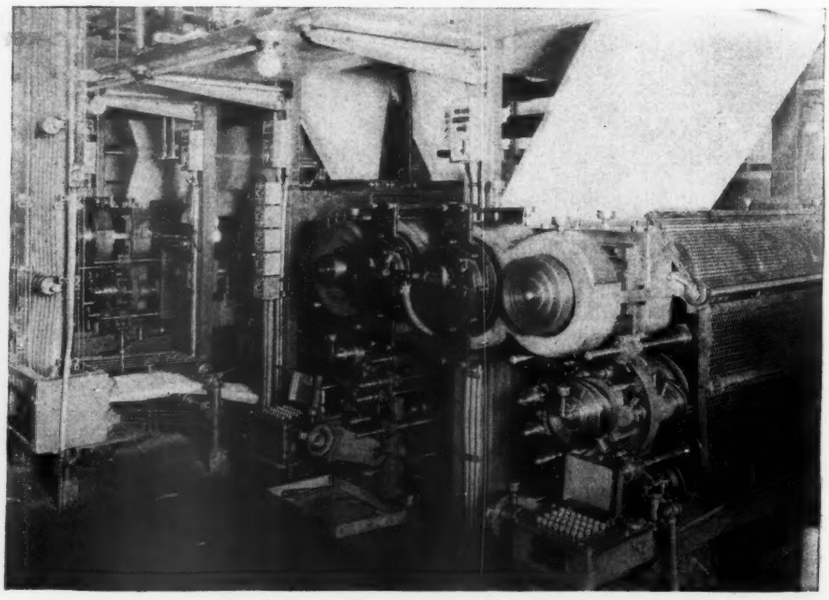
When the paper web breaks while operating at high speed, due to a weak spot or some other reason, it is highly essential to bring the entire press to a stop in the shortest possible time to prevent excessive wrapping of paper around the cylinders and choking at the folders or deliverers and so minimize the waste of paper.

This is accomplished by using specially constructed and magnetically operated disk brakes. One brake is used for a set of printing and impression cylinders. This brake absorbs approximately 41,500 ft.-lb. of energy when the press is stopped from a printing speed of about 48,000 papers an hour. For a complete printing press unit two brakes are connected in series and are attached to one end of the extended cylinder shaft. With this arrangement the stresses and corresponding strains in the various machine elements caused by the stopping are the same regardless of the total load on the motor drive; this load may vary from one press unit to six press units.

Magnetic brakes of the disk type consist of a stationary field member containing the coil supported in a position by brackets fastened to the

* * * *

THE TWO circular black units in the foreground are magnetic disk brakes, installed on the impression cylinders of a modern high-speed newspaper printing press. These brakes consist of a stationary field member containing the coil, supported by brackets fastened to the frame of the machine, and a rotating armature keyed to the extended shaft of the printing cylinder.



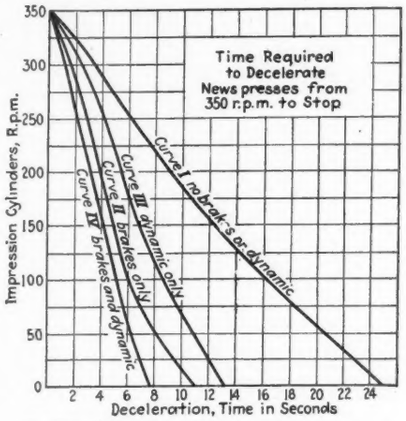
frame of the machine, and a rotating armature keyed to the extended shaft of the printing cylinder. The assembled brake with its supports and the disassembled brake with the spring plate armature and the inside view of the field are shown in an accompanying illustration. The dark ring at the outer circumference is the friction ring which is in contact with the armature when the brake is energized.

Where d.c. motor drive equipment is used the magnetic disk brakes are connected in the dynamic circuit, thereby taking the energy from the motor after it has been disconnected from the line. The brakes are current applied and have a spring release, which means that they automatically release when the driving motor stops.

Where a.c. motor drive equipment is used a small motor-generator set is generally provided to supply the direct current to energize the brakes during the stopping period of the drive equipment. In this case the magnetic brake circuit is interlocked with the controller to open the brake circuit and release the brakes when the machine has come to rest. The installation shown in connection with this article illustrates two magnetic disk brakes on the impression cylinders of a modern high-speed newspaper printing press. This press is equipped with Cutler-Hammer control and a C-H Dispatch conveyor for carrying the printed newspapers from the press upstairs to the delivery room.

The two C-H magnetic disk brakes are the two circular black units in the foreground.

The accompanying set of curves shows the results of tests made on a machine operated with a 60-hp., d.c. motor drive equipment, using magnetic disk brakes for quick stopping



RATE OF DECELERATION of newspaper press showing time in seconds required to decrease the speed of rotation from 350 r.p.m. to a dead stop by various methods of braking. The curve was plotted by setting the stop watch at zero for 350 r.p.m. and taking the watch reading at each decrease of 50 r.p.m. in speed.

* * * *

at the high speeds of 350 r.p.m. of the printing cylinders which is equal to 42,000 papers per hour. It will be noted, from the curves, that the stopping time when using cylinder brakes only is less than the time required to stop when using dynamic brakes only on the motor drive.

The form of this curve and the method of presentation are somewhat unusual and so a more detailed explanation may be desirable. The speed of 350 r.p.m. was the starting point for each test, which is the zero point on the stop watch and the beginning of the time reckoning; reading from left to right are the seconds required for the machine to come to a dead stop. Curve *I* shows the nature of curve and stopping time beginning at zero time, when the "stop" button was pressed, to 25 sec., the total time required for the machine to come to rest from 350 r.p.m. using no braking.

Referring to curve *I*, the decrease in speed from 350 to 200, or 150 r.p.m., required 9 sec., the next 150 r.p.m. decrease required $20.6 - 9 = 11.6$ sec. Also, referring to curve *IV*, the first 150 r.p.m. decrease required 3.2 sec. and the second 150 r.p.m. required $6.2 - 3.2 = 3$ sec. This comparison of the two curves shows the effectiveness of the brakes over the range of speed. In other words, the start of the stop is at 350 r.p.m., which is zero time, but the stopping time is that from zero to the curve on the zero speed or revolution per minute line.

Magnetic brakes of this same type are also used in paper mills on the rewinders to stop quickly when the paper breaks.

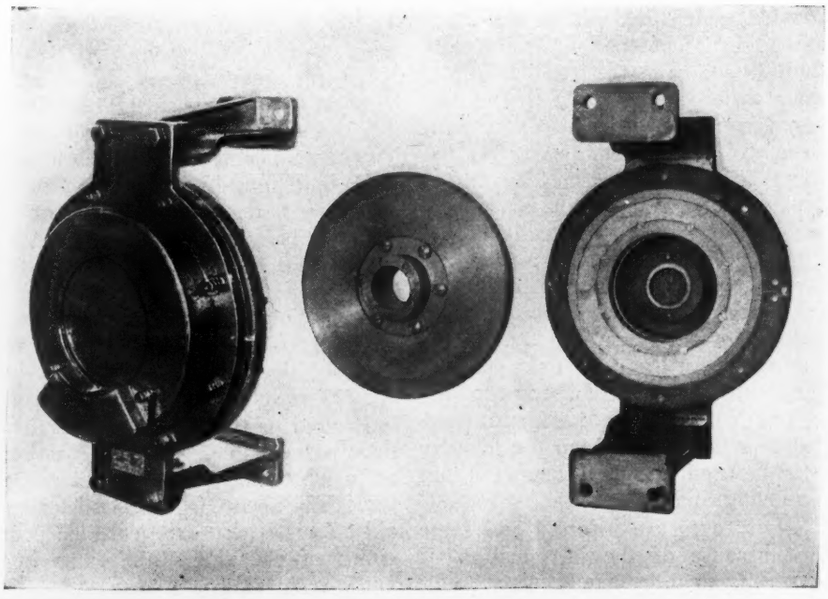
The value of quick deceleration of presses is perhaps better explained by the following examples: In any machine should some machine element or member work loose, such as the gear, the cam, or coupling and more especially, in a printing press, the printing plates, or blanket, it is very important to have the machine stop in the shortest possible time in order to minimize the damage of parts involved. When a plate becomes loose or a blanket wraps between a set of cylinders, frame breakages has resulted in many instances.

On a press printing on tin for canned goods, it is very important when a sheet of metal for a tin can is mistracked in its printing course, to stop the cylinders in about one revolution to prevent injury to the printing plate and also to other machine members by the sheet metal which is fed through the press.

On rewinders in paper mills it is important to stop the machine quickly to prevent over-traveling of the roll and considerable loss of time in removing several of the outer layers

* * * *

ASSEMBLED and disassembled view of magnetic brakes which are used on printing presses and paper rewinders to absorb the strain of stopping and also shorten the period of deceleration. The brakes are the disk type and are operated by direct current. They consist of a stationary field member containing the coil, and a rotating armature which is keyed to the extended shaft.



of the roll of paper that is being wound because of the tendency of the paper being wound too loose when paper breakage occurs.

In printing presses the lost paper due to breakages, if the press is not stopped quickly amounts to several thousand dollars a year. Especially is this true with the larger, or metropolitan printing plants where five and six webs of newsprints are collected in one folder for 48-page papers. In this case when one web breaks, all six rolls are still feeding and the loss must be multiplied by six, as compared to presses operating a single web. When the saving of approximately 100 ft. of good newsprint for each web, or a 600-ft. total, is considered, the value of the paper becomes quite an item in a day's run.

There is also a hidden factor which does not make its appearance while the machine is new, but after a press has operated for a period of five to eight years considerable gear breakages is manifest due to the braking action being applied at the source of maximum torque and the reversing of the stresses.

Machines equipped with magnetic disk brakes, which are located at the members where the greatest amount of energy is stored, do not have this experience. From certain installations that have been in service approximately ten years and from certain tests that have been made recently, two manufacturers of high-speed printing equipment for newspaper, magazine and tin machinery definitely recommend to their customers the application of magnetic disk brakes on their presses.

First Aid for Eye Injuries*

THERE are three cardinal principles of first aid after eye injuries. The first of these is cleanliness; next, prompt rest for the eye; and, third, medical care directed by a competent physician, preferably an oculist. These principles apply even if the injury is slight, and they are imperative with serious eye injuries.

In removing dirt, it is a common custom to lift the upper lid and to push the lower lid with its lashes over the eyeball well up under the upper lid and then to draw down the upper lid. This procedure often enables the lashes of the lower lid to drag out of the eye a bit of dirt or rough material that may be causing great annoyance. The method, however, has all the possibilities of introducing an equally annoying amount of dirt and, what is worse, of sometimes introducing directly from the soiled lashes germs that may find an ideal place to grow in the freshly scratched tissues from which the dirt was removed.

Cleanliness, then, is the first thing to think of. Refrain from pushing the lashes under the lids until the lashes have been washed and be sure that the fingers that are going to handle the lashes and lids are also thoroughly washed. Make certain that the medicine dropper or eye-cup that may be used has been thoroughly cleansed.

A rough bit of dirt blown into the eye may be comparatively harmless if removed quickly and carefully, but with rough manipulation through rubbing of the lids, the dirt may actually be driven into the tissues of the eye or may cause numerous scratches on the lining of the lids or of the conjunctiva covering the eyeball. Broken surfaces are thus exposed to all sorts of infection, and abundant opportunity is given for germs to be carried into the eye tissue with the original particle of dirt.

Make no attempt to remove particles of dirt from the eye until the hands and lashes have been thoroughly cleansed. Next, take a little twist of the cleanest of absorbent cotton, either twisted tight upon its own fibers with a little tufted tail piece, or twisted about a matchstick with a little tuft extending from the end. Separate the lids and note the location of the thing to be removed. With the prepared cotton it is usually very safe to gently drag the tailpiece over the thing to be removed. The cotton drags it out. If no cotton is available and the dirt is on the inside of the upper lid, then, after cleansing the lashes, the under lid may be pushed up under the upper lid, which should then be drawn down quickly, affording an opportunity to drag out the dirt with the lashes of the lower lid.

The corner of a perfectly clean handkerchief fresh from the laundry may be used like this cotton twist in removing dirt.

Many eyes are infected and some lost because of the introduction of germs from dirty hands, dirty handkerchiefs, dirty lashes or dirty materials used in attempting to do the kind thing for the individual suffering with dirt in the eye.

If much scratching occurred during removal of dirt or if dirt has been in the eye for a considerable length of time, great comfort may be had by gently placing a piece of soft linen that has been boiled and wet with cold water, over the eye and then very lightly bandaging the eye. This places the eye at rest, makes easier lifting lids from eyeball by the tears and favors start of the healing process. This is a good procedure to follow until such time as medical advice and treatment may be secured.

In graver injuries, where flying particles may have been driven into the eye tissues and injured the outer covering of the eyeball, it is wiser immediately to cleanse the outer surface of the eye, lashes and lids, place a wet dressing over the eye with a light bandage and secure forthwith medical opinion as to the best method of procedure.

The dirty habits, such as removal of things from the eye by utilizing a matchstick that has been carried in the smoker's pocket for a long while, have been largely discarded. In modern factories and mills nowadays instruction is given to employees in first aid, and, at convenient points throughout the plant, first-aid equipment stations are maintained with clean, sterilized materials such as are used in hospital operating rooms always available.

By closing the eyelids until a good flow of tears accumulates under them and then blowing the nostril hard on the side toward the eye in which the dirt is located, one may often wash the irritating bit of dirt down the nose.

It sometimes happens that an acid burn of the eye is sustained. It is safe immediately to wash the acid-burned area with an alkaline solution made by adding half a teaspoonful of ordinary baking soda (bicarbonate of soda) to half a glass of water, or, in the absence of water, one may put a little of the dry powder into the eye. Introduction of the powder may not be quite comfortable, but it will retard the deep burn and in most instances will be soothing

Printed or typewritten instructions may be available, giving suggestions as to what may be done until a doctor can be secured. In all such first-aid efforts stick to the cardinal principles of cleanliness, doing no hurt and placing the eye at rest.

*By B. Franklin Royer, M.D., Medical Director of the National Committee for the Prevention of Blindness.

Applications of wiring trough in a machine shop

WIRING TROUGH

A distribution system that provides flexibility at low cost

By L. R. BOGARDUS

Chief Electrical Engineer,
The Packard Motor Car Company,
Detroit, Mich.

NUMEROUS changes, rearrangements and shifts of machinery and equipment to meet changing production demands are a big item in the work of the electrical department in an automobile plant. In practically every instance, not only are disconnecting and reconnecting necessary, but the conduit lines and wiring must be taken out and then replaced. This work is expensive and requires considerable time; in fact, it is sometimes impossible for the electricians to keep up with the millwrights, and so temporary connections, with their extra cost, are necessary.

Distribution of the feeder lines through conduits does not have the necessary flexibility to accommodate these changes. Also, approximately only 35 per cent of the cost of a conduit installation can be salvaged; the labor expended in its erection is a total loss and only a part of the conduit, fittings and wire can be reused, even after the expenditure of additional labor for straightening and reconditioning.

Investigating the problem of how to handle the multitude of changes that are necessary in our plant, we noticed that with short conduit runs the electricians were able to keep up with the millwrights. If all runs could be kept short the problem would therefore be simplified. This led to the idea of using a continuous or extended junction box, trough, or duct, containing the feeders. As we conceived it, this duct would extend the length of the shop with short conduit runs from the machines connected to it. Small power panels could be mounted at convenient intervals, or the feeders continue in the ducts to a power panel or from a power panel to a conduit connection to the machine.

At that time there was no duct of this sort on the market; so it was necessary to make up the duct ourselves. Incidentally, some of this old duct is still in use in this plant. Within a short time, however, standard sizes, shapes and connections became available and now between 9 and 10 miles of it are installed in our plant.

Before going further into an explanation of the use of the duct

or wiring trough, it may be well to describe it. This wiring trough, commonly known as Square Duct, is made of 16-gage, black-japanned sheet metal, 3 x 4 in. in cross-section and with the ends flanged for bolting the sections or fittings together. The trough comes standard in 2- and 5-ft. lengths with a spring-hinged cover on one 4-in. side. Knockouts are provided in the other three sides. The cover on each section is independent of fittings or other sections. Fittings do not have covers, although the sides of the junction box fitting are removable. A telescopic fitting renders it possible to make odd-length connections.

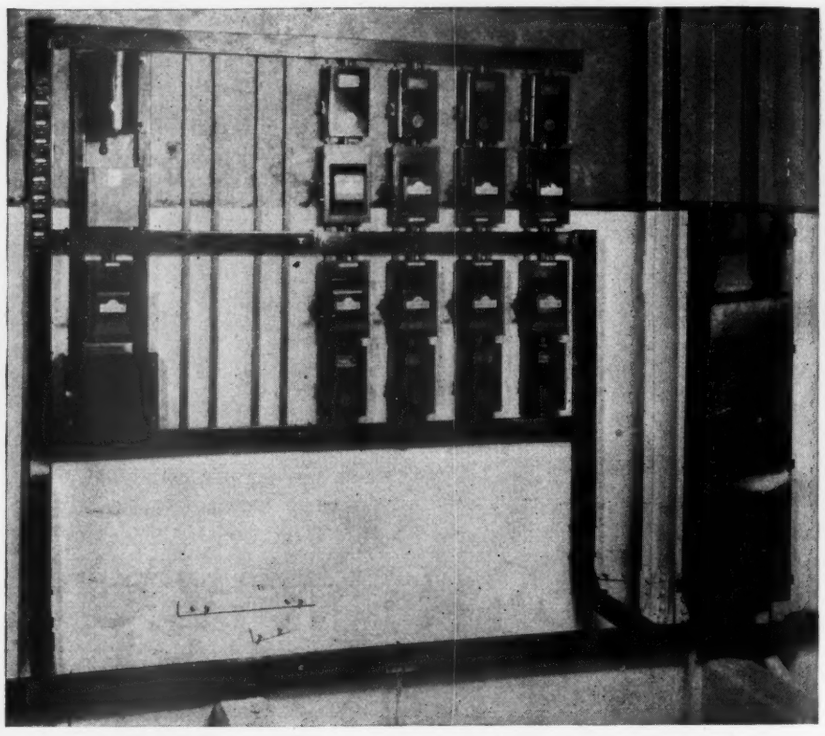
The variety of fittings, connections and hangers available make it possible to use the trough either flat (horizontally) with the cover on top or bottom, or on edge (vertically) with the cover on the side. The drawing on page 251 illustrates the method of supporting the duct (vertically, in this case) by hangers and the use of the telescopic fitting in connecting a duct to a power panel. The fitting in the duct at the top of the telescopic panel is known as a junction box fitting; in this case it is used for a T connection. The side plates of the junction box are removable for accessibility or so that standard units can be connected up on any of the four sides or two ends; thus the fitting can be made into a cross, T connection, or a 90-deg. L. Side and end plates with knockouts in the various sizes can be used for connecting to conduit.

When a run of wiring trough is once installed, it is not moved, ordinarily, irrespective of the amount of changing or shifting of the machinery. However, any necessary additions or alterations can be made easily and all of the duct is salvageable.

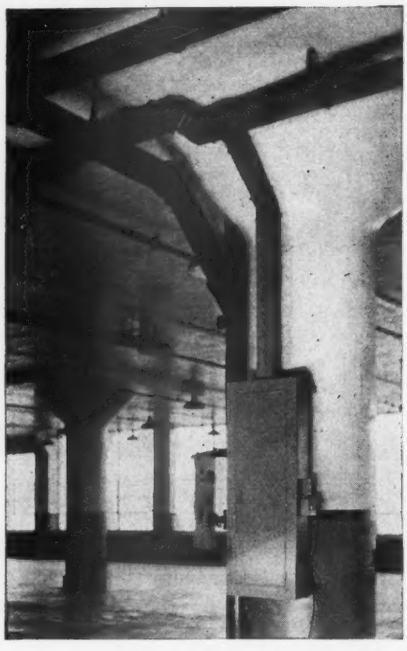
Thus, the installation cost, which is about 40 per cent of the cost of conduit runs on, say, a six-feeder circuit, is practically the only cost. The big saving in installation cost results from the decreased amount of labor necessary and the comparative absence of expensive fittings.

The wires are laid loosely in the trough and connected into the panel. This can be done ahead of time in a new building, for example, so that the distribution system is ready before the machinery is installed. Later, when the machines are placed in position the conduit runs from the machines to the wiring trough are laid out and the wires pulled while on the floor. The runs are then lifted into position and connected up to the machine through a knockout in the side of the trough, or to a small power panel mounted on or near the duct. Or the feeders may be run partly in conduit and partly in the duct. The motor feeders are then connected up to the lines in the trough or to the power panel and the whole job is finished in a very short time. When moving machines out the operation is reversed; the short run of conduit is taken down and the machine is ready for the millwright to take away.

The average building in our plant is laid out so as to be divided into units 60 ft. wide by about 420 ft. long, with one row of columns down the center. Our practice is to install



THE GUTTER for the installation of a bank of line switches and across-the-line, push-button-operated starters is made up from wiring trough. Push buttons are mounted in the cover of the wiring trough, as shown in the lower right-hand corner.



BY USING the proper fittings, wiring trough can be passed around a pipe line and made to fit against the flare at the top of the columns. These fittings are all standard units which permit running the trough anywhere.

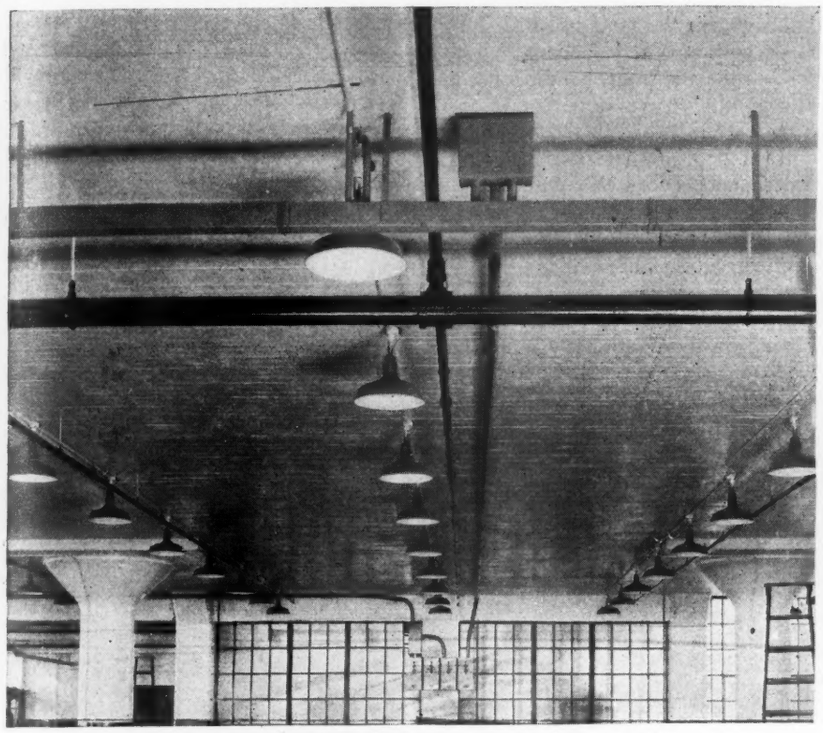
* * * *

a line of lighting feeder troughs the length of this unit along one side of the center row of columns, and a line of power troughs along the other side. We do not mix power and lighting circuits, except that in some departments the high-frequency (usually 180-cycle) lines for portable tools are placed in the lighting duct. Thus, no machine is more than about 30 ft. from the wiring trough or about 45 ft. from one of the columns in the center row.

Ordinarily we plan these installations so that only about 60 per cent of the capacity is utilized, thus leaving ample capacity for expansion. Consequently, about six No. 1 feeder circuits (18 wires) are placed in a new trough installation. The largest number of wires in any trough in this plant is 36, although I believe that 60 wires are used in another in-

stallation. With 36 wires the trough is not full; the wires are easily accessible and can be worked on without tangling.

Wires may be tagged, if desired, to identify them. However, we have found that if neatly placed in the trough they can easily be traced without marking them. If one man pulls gently on a wire or gives it quick, light jerks, another man can easily pick out the wire a considerable distance away. The wires are then tested out as a check, of course. It is always possible to cut into or splice a wire in the trough, whereas this would ordinarily be impossible with wiring in conduit.



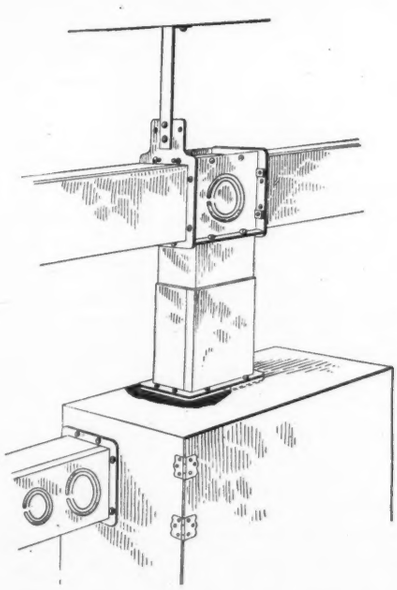
CONDUIT LINES are sometimes used on parts of runs that will not be affected by shifts or changes of equipment. Here is a long run across the ceiling to the wiring trough in the foreground

* * * *

Eight-circuit power panel boxes are cut in wherever desired. We prefer to use a larger number of small boxes, rather than a few large ones, because they can be placed closer to the machines, which means shorter runs and also provides a more flexible arrangement. Flexibility is of the utmost importance in our work. In addition, small boxes are always more easily used elsewhere than large ones.

Wiring trough is easily erected. On a new job recently four men assembled and erected a run of 420 ft. of trough on a concrete ceiling in 14 hours. The sections of trough were bolted together on the floor in 30-ft. lengths and then three men carried them up ladders and fastened them to the inserts which are cast in the ceiling on 8 x 10-ft. centers. If inserts are not available the ceiling is drilled for expansion bolts.

The method of support differs with the type of ceiling. In a number of instances, as in mounting lengthwise of a sawtooth roof, the wiring trough is supported from a span wire stretched the length of the bay. In other instances the trough is attached to the steel structure, or fastened to the wall. I know of an instance where the trough is supported on $1\frac{1}{2}$-in. pipes set in the floor. In a large proportion of our installations the wiring trough is mounted vertically—that is, on the side—because of the greater accessibility with the cover at the side. Also, mounting it in this manner permits of making conduit connections on the top side of the trough. Where the trough is mounted upside down, the feeders are held in by crossrods or spreaders which also strengthen the open side of the trough.



METHOD OF CONNECTING wiring trough to power panel. The wiring trough comes in 5-ft. and 2-ft. lengths with the ends flanged for bolting together. The telescopic fitting shown at the top of the power panel is used to make odd-length connections.

Many other uses are made of this duct, in addition to providing a permanent housing for power and lighting circuits. In some instances we attach the lights to the bottom of the duct and connect them to the wires inside. A plug receptacle is mounted in a knockout in the bottom of the trough and the fixture is supported by a chandelier hook and connected through a push plug on a fixture loop To clean the fixture, it is disconnected, unhooked and brought down to the floor to be washed. In some instances fixtures are mounted on conduit runs and connected into condulets in the same manner. This method of mounting on the duct or conduit soon saves its extra cost through the greater accessibility and convenience.

In several instances banks of disconnect switches and across-the-line starters are mounted as shown in the illustration on page 250.

Plant men who have a battery of temperature indicating and recording meters in connection with the control of heat-treating furnaces will realize the value of the accessibility and other advantages gained from using this type of trough to wire up the instruments and make the connections with the furnaces. Accessibility at all points is of the utmost importance in such installations.

We have found that by using wiring trough instead of conduit we can make a saving of about 40 per cent in the original cost of installation, and will average about 60 per cent saving or more on each change or addition. We feel that the additional flexibility and convenience thus gained would make it worthwhile to use the wiring trough, even though it were more expensive.

Materials Handling Division, A.S.M.E. Holds Its First National Meeting

UNDER the auspices of the Philadelphia Section of the American Society of Mechanical Engineers, the Materials Handling Division of the Society held its first national meeting on April 23 and 24 in that city. The Materials Handling Division, which initiated and promoted the idea, and the Philadelphia Section, which acted as hosts to the gathering, are both to be congratulated for a sincere attempt to bring about a better understanding of what materials handling means to industrial production.

Headquarters for the meeting were established at the Benjamin Franklin Hotel. J. G. Hatman, chairman of the Philadelphia Section, presided at the opening of the technical session on the morning of the opening day and acted as toastmaster at the dinner on the same evening. The afternoon session was devoted to trips of inspection to plants in and near Philadelphia.

Members were given their choice of trips, according to the type of equipment or handling problem in which their particular interest lay. The materials handling installations selected for this purpose by the committee were in the following plants: Sears-Roebuck & Company, Atwater-Kent Mfg. Company, Reading Railroad coal piers and grain elevators, Victor Talking Machine Company, Curtis Publishing Company, U. S. Cast Iron Pipe & Foundry Company, the Pennsylvania Railroad's perishable products and fruit terminal and that of the Baltimore & Ohio Railroad.

At the dinner, attended by more than 200 members and guests, Chairman Hatman introduced the speakers of the evening. C. D. Young, general purchasing agent of the Pennsylvania Railroad, and E. J. Mehren, vice-president of the McGraw-Hill Company.

Mr. Young showed how modern facilities had overcome the bogey of material shortage, through better transportation and handling methods and equipment which made it possible to meet unexpected emergencies.

Mr. Mehren presented an interesting outline of what Germany is doing to increase the efficiency of her industrial production, with particular reference to its meaning to American industry in competing for the world's markets.

Mr. Mehren mentioned that the opinion prevails among certain German industrialists that they will not only equal but outstrip this country, industrially, in the next twenty years. In this connection, he reminded his hearers that the most immediate as well as the largest opportunity for successfully meeting this competition lies in the field of materials handling; a function where, in this country, we still have far too large a proportion of manual work and in which we employ too much of our labor.

Among the papers presented at the technical sessions, Edwin P. Smith, engineer of the National Cash Register Company, gave a description of the modern installation, at the Dayton plant of that company, whereby spray painting and enameling of the product are accomplished "on the move." Harry S. Parks, engineer of the Holley Pneumatic Systems, Inc., presented a discussion of pneumatic handling of materials in manufacturing plants, showing the progress that has been made to date in this specialized field.

Frank D. Campbell, chief engineer of Eastern Steel Castings Company, presented a comprehensive description of materials handling methods at that plant. Summing up the results of this system, Mr. Campbell said that it had transformed a conventional type of jobbing foundry into a systematic manufacturing unit. To anyone familiar with the average jobbing foundry, this comes close to expressing the achievement of the impossible.

Other papers presented at this meeting covered a wide variety of materials handling problems ranging from the handling and transporting of crude materials to the linking of processes and handling methods in various industries.

Moving spirits behind this, the first attempt to bring together in a national meeting the engineers interested in the progress of the science of mechanical handling, were the executive committee of the Materials Handling Division, A.S.M.E., consisting of P. H. McLain, chairman; Matthew W. Potts, secretary, and Messrs. J. A. Shepard, F. D. Campbell, G. E. Hageman and C. D. Bray. Co-operating in the arrangements for the meeting was the executive committee of the Philadelphia Section of the A.S.M.E., of which J. G. Hatman is chairman, H. A. Hoffer, secretary, and the remaining members are J. H. Billings, H. S. Harris, W. W. Beyer and H. S. Parks.

F. M. Gibson To Be Consulting Editor

WE ARE gratified to announce that F. M. Gibson, of the American Sugar Refining Company, is to become Consulting Editor of *Industrial Engineering*. Mr. Gibson is one of the foremost plant engineers of this country and

has been closely associated with progressive movements designed to elevate the professional standing of plant engineers and to increase the effectiveness of their service to industry.

Mr. Gibson graduated from Stevens Institute of Technology as a mechanical engineer in 1901. From then until 1903, he was assistant to the Steam Engineer, Cambria Steel Company, at Johnstown, Pa., going from there to the San Carlos Copper Company, at San Jose (Tam., Mexico), as Assistant Engineer.

In 1905 Mr. Gibson became foreman engineer of the Jersey City Refinery, American Sugar Refining Company; from 1910 to 1927 he was plant engineer of the Boston Refinery of that company, and he is now plant engineer of the Brooklyn, N. Y., plant. He is chairman of the A.S.M.E. Committee on Meetings and Papers on Industrial Power and a principal in the composition of the Plant Engineers' Code.

QUESTIONS *Asked and Answered* *By Readers*

[HERE IS A PLACE *where you can get some inside information when you get stuck. The only restriction is that you do a good turn to the other fellow when he asks a question that you can answer from your experience*]

Test Panel for Repair Shop

I wish some reader would give me the layout and description of a suitable test panel for our repair shop. We use 220 and 110 volts direct current and I wish to be able to test and run 220-volt direct current motors up to 7½ hp. rating, by plugging into the board. For testing we will, of course, need a volt and an ammeter. I should also like to install a receptacle for a 110-volt electric iron and a 110-volt test line. I should like to be able to cut the voltage down on this, or another test line, by putting lamps or heating elements in the circuit.

Chicago, Ill. F. J. C.

* * * *

Reducing Voltage to Ground on Distribution System

We are buying a three-phase, 220-volt, 60-cycle power and use a balance coil for our lighting circuit, but have no grounded neutral. With all except our main switch thrown in we have an insulation resistance value of 1.5 megohms on each pole, but when we close the main switch the voltage to ground on the three phases is 96, 146, and 87 volts respectively. We cleared up all circuits until our Megger showed a low insulation resistance value of 10 megohms, but found there was no change in our voltage to ground. During another test we opened all circuits feeding the various buildings and took voltage readings when a switch was closed. The test showed that we have 45 volts to ground on each leg of our power line. When lighting switches were put in the volts to ground increased 4, 6, 10 and 15 volts respectively. The circuit which showed an increase of 15 volts to ground gave a reading of 20 plus megohms on the Megger. Will some reader tell me what to do next to clear up our trouble?

Passaic, N. J. R. B.

* * * *

Should Extra Men Be Hired or Work Sublet?

I should like to get the opinions and experience of readers in different parts of the country on the following question: Assume that the chief electrician of an industrial plant is capable of installing all new equipment, but has only a small force of men under him. When a big job is to be done, is it more economical or desirable to hire extra men at open shop wage rates to install the equipment, than to sublet the work to an outside electrical contractor?

Providence, R. I. W. D. B.

* * * *

Lubricant for High Temperature

It is necessary to operate a worm speed reducer in connection with an oven where the temperature of the air at the reducer is about 150 deg. F. The reducer is overrated about 50 per cent because of the service conditions, but the air will not radiate the heat away fast enough. The worm is mounted above the gear so that the lubricant must be carried up to the worm, but, because of the temperature, has too low viscosity to stick to the gear teeth, I believe. What kind of oil should be used in a drive of this type? Can anything else be done to improve this drive?

Detroit, Mich. S. L. G.

ANSWERS *Received to Questions Asked*

Question

Relation Between Power Factor and the Coal Pile

In trying to improve the operating efficiency of our plant a question has come up regarding the effect of power factor. We generate our own power and use about 600,000 kw.-hr. annually. Our generating and distribution equipment is of ample capacity, although we are operating at a power factor of only 65 per cent. I understand the effects of low power factor on the distribution system, but should like to know just how it affects the coal pile. I wish some reader would explain this, as I want to determine whether it will pay us, from the standpoint of fuel economy, to raise our power factor to 90 per cent, or thereabouts. E. A. W.
Toronto, Can.

A COMPLETE answer to the question by E. A. W. cannot be given without more data to cover all the factors in the case. Fundamentally, increasing the power factor decreases the amperes for the same kilowatt output, which in turn cuts down or reduces the copper losses in kilowatts, hence reduces the annual kilowatt-hour generation for the same load. It follows, therefore, that a kilowatt-hour output decreases the coal consumption for the period considered. The decrease in losses applies to the generating equipment as well as the feeder circuits since the efficiencies are higher. Obviously the coal consumed in the station in pounds per kilowatt-hour or some standard unit should be obtained from the operating records of the station.

We know that in a three-phase system

amp. = watts ÷

($\sqrt{3} \times$ volts $\times$ per cent power factor)

It follows from the foregoing that the closer the power factor approaches 100 per cent, the lower the current will be, and the lower the generator input will be from the driving end to take care of the decreased losses in the generator windings.

Since the main factors to be considered are the higher generator efficiencies due to rise in power factor and lower losses in the feeders, the point is brought up as to where the power factor shall be raised, whether at the station itself or at some distant point, say, at the end of a heavy feeder or a number of feeders. If raised at the station end only, the gain will be only in the increased generator efficiency less the losses in the power factor corrective equipment, whether an idle generator unit carrying only a high volt-ampere load or some synchronous equipment. If a survey indicates that a number of feeders require correction, consideration should be given to placing corrective equipment of the synchronous or so-called static type at certain load centers.

As a general statement, it will undoubtedly pay to raise the power factor from 65 to 90 per cent even with increased interest charges on the corrective equipment, but in the absence of any quantitative information no definite advice can be given. The questioner may submit his data to the writer, if he desires a final answer.

C. O. VON DANNENBERG.
Electrical Division,
General Engineering & Management Corporation,
New York, N. Y.

REGARDING the question by E. A. W., the economical loss resulting from low power factor is the increase in copper or RI^2 losses caused by the current which must be carried in excess of that required for an equal load at unity power factor.

The total losses will be equal to the losses at unity power factor times the reciprocal of the power factor squared. In this case, we will assume that the copper losses at unity power factor are 5 per cent. If the cost of energy is 2 cents, the copper loss at unity power factor would be one mill. Therefore, at 65 per cent power factor the loss would be 2.366 mills. If the power factor were raised to 90 per cent the losses would then be 1.23 mills, or 1.136 mills less than at 65 per cent power factor. For each kilowatt-hour lost in the distribution system there would be a saving of 1.136 mills by raising the power factor from 65 to 90 per cent.

Assuming the annual losses to be 30,000 kw.-hr., the saving would amount to $34.08. In addition to these losses, there is the additional investment in electrical equipment required to handle the excess current which, of course, results in higher fixed charges. Interest on this investment must be added to the operating losses to determine the total loss occasioned by low power factor.

If his generating and distribution systems are large enough as he states, to carry this excess current, I doubt very much whether the expenditure of money in corrective apparatus would prove an economical investment. It appears to me, without other details, that it is cheaper for him to carry the current until such time as additional loading demands greater generator or distribution capacity, at which time corrective apparatus can no doubt be used to advantage.

For the time being I would suggest that E. A. W. study carefully the load conditions of each motor in his plant, in view of the possibility that rearrangements which would be made with little expense might be helpful. The chances are that his present low power factor is due to a great extent to cases of overmotoring. Changing motors around so that they will operate at nearly full load will improve the power factor of a plant considerably, without much expense. B. W. SCOTT.

Question

Speed of Single-phase Motor Varies Widely

Will some reader please tell me what is wrong with a motor having these nameplate data: G. E. repulsion, single-phase, Type 526-4-1-5-750, Form C, cycles 60, volts 110/220, amp. 4.34-2.17, continuous 55 deg. C. This motor drives a 30-in. exhaust fan. Its maximum speed has been around 400 r.p.m., which would gradually decrease until the motor finally stopped after several hours of operation. The temperature of the motor frame was found to be about 104 deg. F. with a room temperature of 62 deg. F. I found that by pushing the rotor forward against the front bearing it would run freely again. So I put a $\frac{1}{16}$-in. fiber washer on the commutator end of the shaft. I found then that the speed had increased to 2,600 r.p.m. and on successive trials I found speeds of 2,700, 2,800 and 3,100 r.p.m. Why did the motor run so slowly at first, and what caused it to reach such an abnormal speed later? F. H. C.
Brookhaven, Miss.

IT MAY be that F.H.C. has a motor on which the nameplate data have been stamped incorrectly or indistinctly. I could not find, in a General Electric catalog, a standard motor with the data he gives. However, his motor might be a special design and, therefore, not listed. On the other hand, I did find a motor with these data: 526-4-1-.5-1,750, which would be interpreted as Type 526, four poles, single phase, $\frac{1}{2}$ hp., 1,750 r.p.m. This would be about the right size of motor for a 30-in. exhaust fan, although the speed is rather high.

The question does not state how long the fan has been operating, or whether it is new. On exhaust fans a thrust bearing is usually provided, whose location depends on whether the motor is in front of the fan and pulling the exhaust air toward it, or is behind the fan and pushing the air outwards. The latter is the usual construction and allows the motor to be housed by the building or chamber from which the air is to be exhausted. This thrust bearing is adjustable and its construction varies with the design. Its purpose is to prevent undue friction between the armature or rotor shoulder and the end of the bearing or the motor frame. It is usually placed in an accessible position away from the pulley or fan end.

The idle washer on the shaft constituted a thrust bearing and probably explains why the motor speeded up.

The speed on this type of motor varies with the load, voltage, and brush setting. If the motor was not designed for operating the fan, it may not be sufficiently loaded. Again, the voltage

ANSWERS *Received to Questions Asked*

may be incorrect for the connection now used on the machine: that is, it may be connected for 110 volts and be operating on 220 volts, or vice versa. Furthermore, I believe that the brushes are not set in the correct position.

If this is found to be the case, they can be reset by trial. I would also examine the brushes to see whether they are loose or are not making good contact. Carefully examine the leads to the brushes to see whether they are loose or broken. The fact that the motor stopped after a few hours of operation proves that it was not operating properly, and I believe that it is connected for 220 volts, but is operating at 110 volts. Otherwise, it would probably have burned up or blown the fuses when it came to a dead stop.

The theory that the motor is operating on abnormally low voltage is also supported by the fact that with a room temperature of 62 deg. F., or 17 deg. C., the temperature rise was only 104 deg. F., or 40 deg. C. This shows that the motor is not overheating because it is rated at 55 deg. C., which is equal to 131 deg. F. If the motor were operating at reduced speed and finally stopped it would, if designed properly, assume a very high temperature.

The motor probably has four leads brought out of the frame. If these leads are put in series, the motor will be connected for 220 volts; if the leads are in parallel the motor will be connected for 110-volt operation. The voltage supply of the circuit is, no doubt, known but it might be well to check it. If the motor has four leads they will more than likely be marked T-1, T-2, T-3, and T-4. If this is the case, connected leads T-1 and T-4 to the line and T-2 and T-3 together for 220-volt operation. For 110-volt operation, connect leads T-1 and T-2 to one line, and the remaining leads to the other line.

If the motor is designed for reversing operation, eight leads will probably be brought out, but only four will show on the terminal board. The terminal block can be removed with a screwdriver, and the leads will be found to be marked from one to eight. For 220 volts, these leads should be connected thus: T-5 to T-6, and T-7 to T-8. For reversing service at 110 volts, T-4 should be connected to T-7, T-3 to T-8, T-2 to T-5 and T-6 to T-1.

If F.H.C. will check up some of the above points I believe he will find the cause of his trouble.

GRADY H. EMERSON.
Birmingham, Ala.

I BELIEVE that F.H.C. made a very slight mistake in copying the nameplate data. As a rule General Electric nameplates give the frame number, number of poles, horsepower and speed. F.H.C. reported these data as 526-4-1-5-750. I do not understand what the figure 5 means unless it should be a 1, making the speed 1,750 which seems to be right in view of the 4 following the frame number.

Assuming this to be the case it is possible that the rotor was binding it to stop after a short run. Or it may be that there was too much end play in the rotor, causing poor commutation which was remedied by placing the washer there. Then while the motor was in that condition it is possible that someone adjusted the brushes to the desired speed, thereby causing the trouble in the first place.

It is not unusual to have a repulsion-type motor attain such high speed if the brushes are not set properly. There does not seem to be anything radically wrong with the motor and I feel that if F.H.C. will put a tachometer on the machine and adjust the brushes to the proper speed he will find that his trouble is over. J. M. PETERSON.
Troy, N. Y.

Question

Emergency Lighting from Current Transformer

We have a 440-volt motor in service at a considerable distance from the 110-volt lighting system. In the one phase of the motor circuit there is a 20:5-amp. current transformer for operating overload trips. Inasmuch as we do not want to extend the lighting system for only one lamp, and do not wish to install four lamps in series, will readers tell me whether I can cut a lamp in the secondary circuit of the current transformer? If so, what size and type of lamp should be used? A. K. R.
Superior, Wis.

ANSWERING the question by A.K.R., in my opinion, his plan is entirely impracticable for the following reasons:

Under normal conditions the secondary voltage of a current transformer is very low, and it varies with the load. Since the primary side is in series with the line to the motor, there is no difference of potential in the secondary unless the line is carrying current. Even if A.K.R. did succeed in hooking up a lamp on the secondary, it would not be convenient to light the lamp while the motor was idle.

If the lamp was connected in parallel with the trip coil, a part of the normal tripping current would be shunted through the lamp. This would make the overload device inaccurate, unless an adjustment were made to compensate for the lamp load.

If the lamp was connected in series with the trip coil, the resistance of the lamp probably would limit the current passing through the coil sufficiently to make the overload trip device inoperative. Furthermore, in case of a lamp failure, the secondary of the transformer would be opened and an excessively high potential would build up in the winding. This potential, probably several thousand volts, would damage the transformer and, besides, would be dangerous to the operator.

The proper solution of this problem probably requires the use of an ordinary potential transformer, rated 440:110 volts, connected across the 440-volt line. Such transformers have a capacity of 200 va., which is approximately equivalent to a 200-watt lamp load on the 110-volt side. N. COOK.
Totowa Boro, N. J.

ANSWERING the question by A.K.R., it is not practical to connect a lamp to a current transformer as suggested in the question.

As this current transformer is connected to a line supplying a motor, the secondary current of the transformer probably varies up to 5 amp. at full load, while the secondary voltage will be just sufficient to force this current through the low resistance trip coils, or some other device, which usually requires only a few volts.

So it is evident that any additional resistance in the secondary circuit will result in the secondary voltage increasing in value, and if the lamp should burn out, thus causing the secondary circuit to be opened, the transformer would, undoubtedly, be damaged.

PHILIP N. EMIGH.
Chief Electrician,
Byrne Gas Coal Company,
N. Fairmont, W. Va.

ANSWERING the question by A.K.R., it is not practical to connect a lamp into the secondary circuit of a current transformer on account of the hazard and the various factors involved.

In the first place the intensity of the light will vary, because the voltage across the lamp terminals will vary with every change in the motor's load. Then again, if the lamp should burn out, the secondary circuit of the transformer will be opened, probably causing damage to the transformer.

Putting the light in the secondary circuit will also affect the operation of the trip coils, or other equipment connected in the circuits, which is installed to be actuated by the current transformer.

V. E. JOHNSON.

REPLYING to A.K.R.'s question, assuming that the current transformer has sufficient capacity to take care of the lamp, the lamp must be connected either in shunt or series with the overload trip coil.

If connected in series, the lamp will

ANSWERS *Received to Questions Asked*

receive the same current as the trip coils, and it is obvious that the current will vary with the load; the lamp giving anywhere from 0 to 5 amp. according to the motor load.

If the lamp is connected in shunt with the coils, the secondary voltage will also vary with the load. The voltage across the coils must, of course, vary with the load in order to force the proper amount of current through the trip coils.

Connecting four lamps in series on this motor circuit is apt to lead to various troubles; so if impractical to extend the 110-volt lighting circuit, I suggest that A.K.R. get in touch with some manufacturer of small air-cooled transformers. EDWARD D. CARTER.

Engineer,
The Baylis Company,
Bloomfield, N. J.

Question

Preventing Damage to Product by Fine Dust

We are having trouble from fine dust settling on our product (shoes) in the room where these are dressed, cleaned, and packed for shipment. These operations are performed in the packing room, and require from one to two days. We have very delicate leathers and fabrics to deal with and when fine dust settles on them it spoils the appearance and frequently causes damage. The floors and walls are of concrete. The dust, however, is not caused by wearing of the concrete floor; it is the usual fine dust found everywhere in offices, and plants. We have tried several different kinds of oils on the floors, but these did not help us much. We have thought of installing ventilators that would draw the air out of the room, but feared that this would stir up still more dust. We will appreciate any suggestions that readers can give us on how to overcome this trouble. R. M. S.
Lynchburg, Va.

IN ANALYZING the problem submitted by R. M. S., several features which are not immediately noticeable, and which he has not brought out, present themselves. He has eliminated the matter of floor dusting; thus, the dust that is causing the trouble must originate outside the room.

Study of ventilation and air conditioning problems shows that a constant interchange is going on between the outside and inside air through innumerable minute crevices that are hardly visible. Again, much air flows through the larger openings, so that, altogether, large quantities of air pass in and out of the room. The amount of air circulated in this manner will vary with the size and number of the openings, the relative temperature and humidity, and the height of the walls. The velocity of the wind and the exposure of the walls will also have an effect. The problem is thus rather complicated and as the pressure difference required to create circulation is small, we may have the air entering and leaving the same room at several points simultaneously.

All air, unless especially conditioned, carries some minute particles of foreign material with it, which is commonly called dust.

These particles will accompany the air through very small passages and nothing but an air-tight seal appears to be effective against them. A considerable amount of dust will collect in the so-called dustproof cases of electrical instruments after several years of use. It may thus be accepted that any normal movement of air will carry some objectionable dust.

It will, therefore, be necessary to look to an abnormal movement of air for relief. A slight air pressure maintained by a fan blowing air into the room will effectually prevent the entrance of any air except that from the fan. In this case, the only dust that will be admitted will be in the air coming from the ventilating fan.

An air filter or air washer will eliminate this objectionable dust, and can be made to temper the air so that open windows or ventilators as suggested, will not be required.

This class of equipment is now used in many industries in which the air must be conditioned to maintain proper working conditions. Equipment for cleaning and conditioning air to any predetermined point of temperature and moisture content, with automatic control to maintain the desired conditions, is now available. T. H. ARNOLD.

Electrical Engineer,
Youngstown, Ohio.

IN REPLY to the question by R.M.S. there are several ways of approaching the problem of eliminating dust.

Dust that comes from concrete walls, ceilings, and floors can be eliminated, first, by painting the walls and ceiling and treating the floor with a floor hardener, or by the application of floor paint. If this does not remedy the condition, all air which enters this room should be sent through an air washer or air filter. This can be done by using a properly designed ventilating system, and closing all doors, windows and partition openings so that no air can enter the room unless it passes through the washer or filter.

With the proper system, all air can be recirculated so that no heat will be lost, and the air can be kept at normal room conditions from the point of view of health and temperature, regardless of the nature of the product.

Such systems for air conditioning are in actual operation in many industries where constant temperature, humidity and dust prevention are very important. K. D. HAMILTON.

Mechanical Department,
Geo. E. Keith Company,
Boston, Mass.

Question

How Can Motor Shaft Be Demagnetized?

We have a 100-hp., 230-volt, 900-r.p.m. motor equipped with sleeve bearings in which ordinary bicycle chains are used instead of the customary oil rings. The chains have operated satisfactorily until recently when the one in the commutator end bearing failed to turn when the motor was started; nor would it run even when the armature had reached full speed. The pulley-end chain turned as usual. It was then found that the motor shaft was quite strongly magnetized—the commutator end much more so than the pulley end. The motor frame is grounded. The field coils, armature, and brush-holders are not grounded to the frame. Will readers please let me know whether there is any way to demagnetize the shaft? Has any one else had a similar experience and found a remedy? G. E. G.
Norwich, Conn.

I suggest that G. E. G. test the motor field for shorted and also for reversed coils, as in the case of a reversed field he would likely get the condition to which he refers. I saw a case of this kind at one time when the homopolar action was so great that the oil film was broken down and the motor bearings ran hot at no load. W. M. PRICE.

Seattle, Wash.

THE trouble G. E. G. is experiencing with a strongly magnetized armature shaft is not uncommon. I have come across the same condition on three occasions, and in each case the trouble was due to an unbalanced field condition.

In the first case a field coil was reversed. In the second, a field coil was almost completely shorted out. In the third instance a grounded field coil was causing the trouble.

I would suggest, therefore, that G. E. G. test the field coils of his motor with a voltmeter for voltage drop. HARRY E. REINHOLD.

Chief Electrician,
American Sheet & Tin Plate Company,
New Philadelphia, Ohio.

DEMAGNETIZING a motor shaft, such as G. E. G. proposes, will probably be very difficult to do and even if successfully done, there is no assurance that the shaft will remain demagnetized for any great length of time. I am of the opinion that the most satisfactory solution of this problem is to remove the ordinary steel (or iron) bicycle chain now used in place of oil rings and substitute either the customary brass oil ring or a brass chain oiler. CHAS. A. PETERSON.

Chief Electrician,
Fairbanks Exploration Company,
Fairbanks, Alaska.

AROUND THE WORKS

THIS SECTION *is especially devoted to short articles describing ideas and practical methods devised to meet particular operating conditions. The items may refer to mechanical details of installation, inspection, testing, wiring, repair, maintenance, replacement, and emergency or unusual installations of equipment tributary to production. Special attention is given to shop or bench tools and short cuts or improved methods of handling work brought into the repair shop. Contributions from our readers are always welcome.*

* * * *

Inspection in Damp Atmosphere Cause of Condenser Failure

STATIC condensers, which are now used in many industrial plants to improve the power factor, are usually fairly free from breakdowns. The following failure may, therefore, be of interest. A three-phase, 160-kva. oil-immersed condenser gave trouble by overheating so much that it could not continue in operation.

The condenser was removed and inspected. When opened up, it was found that six of the units had been practically destroyed by internal arcing, and that the capacity of the remainder had been greatly reduced. This was found to be due to moisture and the condenser was fitted with new units.

The oil was tested and found to contain a trace of moisture, but it did not seem possible that the moisture in the units could be due to this alone. The trouble was afterwards found to be due to the condenser having been opened up some time previously for examination. The atmosphere was very damp and as the units were exposed for some time, they absorbed moisture from the atmosphere, which afterwards was responsible for the breakdown. It would seem, therefore, that a short exposure to a damp atmosphere is quite sufficient to cause trouble by depositing moisture on units such as these with a large area. For this reason, when opening up static condensers for inspection or repair, do it in a dry atmosphere.

Brentford, England. W. E. WARNER.

Increasing Power Output by Reconnecting Transformers

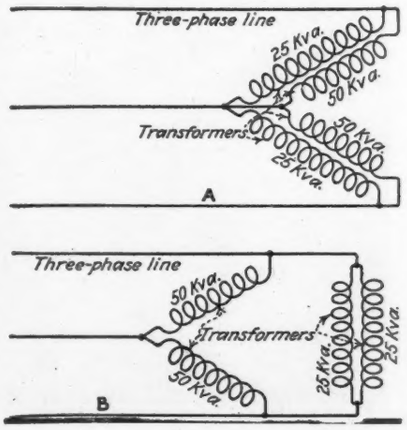
RELIEVING overloaded distribution transformers of their excessive load simply by changing from open delta to closed delta connection is a method that was recently applied by the writer. It was noticed that two 50-kva. transformers connected open delta to supply a power feeder were usually hot and in danger of burning out. It was evident that the transformers were overloaded excessively.

On further inspection of the system it was found that two 25-kva. transformers, also connected open delta, which had been added previously to the same feeder, were installed further down the line. These transformers were likewise found hot. The transformers were installed in such a manner that one 25-kva. and one 50-kva. transformer constituted a set in parallel across one phase and another 25 kva. and one 50-kva. constituted a second pair across another phase. Diagrammatically the connections were as shown in *A*.

New transformers were on order but, because of the danger of a burnout occurring before their arrival, something had to be done with the present equipment, if possible. It was evident that the combined capacity of the 50-kva. transformers connected in open delta was not 100 kva., but only 86.7 kva. Likewise, the two 25-kva. transformers had a combined capacity in open delta of only 43.35 kva. instead of 50 kva. The aggregate capacity was only 130 kva. instead of 150 kva.

* * * *

CHANGING FROM OPEN TO CLOSED DELTA, because with the overload conditions on the line the transformers on the open delta connection *A*, overheated excessively. Computation showed that because of the connection they were rated for a 130-kva. load. Reconnecting to closed delta *B* brought the rating up to 150 kva. and so relieved the condition until new transformers could be obtained.



The 25-kva. transformers were disconnected from the feeder and connected in multiple with each other across the open phase as shown in *B*. This combination gave a closed delta connection and the full capacity of 150 kva. was obtained which represented an increase in capacity of more than 15 per cent. The load on the transformers was still in excess of 150 kva. but there was an appreciable reduction in temperature and the overload was carried satisfactorily. HARRY J. ACHEE.

Superintendent,
Municipal Water & Light Department,
Woodward, Okla.

Oil Rings for Emergency and Permanent Installations

IN AN emergency a very effective oil ring may be made from a long spiral spring. The spring should be small in diameter, but heavy enough to maintain an approximately circular shape when it is looped around the shaft and the ends hooked together. If a suitable spring is not available one may be quickly formed on the lathe, by wrapping No. 18 piano wire around a $\frac{1}{2}$-in. mandrel.

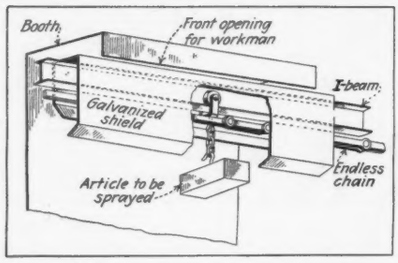
For a more permanent installation one may use a length of Baldwin roller chain of a small pitch. The pitch should not be more than $\frac{3}{8}$ in. for use on a 3-in. shaft, and should be in proportion for smaller or larger shafts.

Such a chain oiler will carry a large amount of oil, compared to other types, the chain links acting as pockets to hold the oil.

Protecting Chain Conveyor From Paint in Spray Booth

IN AUTOMOBILE and other plants where work to be spray painted in booths is carried past the operator on a chain conveyor, some method must be used to protect the conveying equipment, otherwise it will collect such a coating of paint as to interfere with its operation. The protection given in one automobile plant is shown in the accompanying sketch.

In this plant the pieces to be spray painted are carried through spray booths about 5 ft. square on trolleys supported from an I-beam and connected and operated by an endless conveyor chain. The piece is hooked to this trolley. Before the sheet-metal shield was installed as shown it was necessary to clean the chain frequently, which was an expensive operation.



SHEET-METAL SHIELD keeps paint from conveyor chain in spray booth.

* * * *

The shield extends beyond the booth at each end and fits rather closely down over both sides of the I-beams and trolley and extends below the hook which supports the part to be painted. This keeps practically all the paint except some fine spray from the trolley. The shield is easily removed for cleaning or to get at the chain or trolley.

Flint, Mich. G. R. WILSON.

Ammeter Leads That Facilitate Testing

A VERY convenient and efficient set of ammeter leads for testing purposes may be made by screwing or soldering two wires of suitable length to the two end ferrules of a blown cartridge or knife fuse. The opposite ends of the wires should have lugs soldered to them.

When making a test, the regular fuse is removed and the dummy carrying the leads is inserted in its place.

In my own plant this scheme has proved to be so useful that in several instances I have installed a fourth fuse block in a three-phase circuit, connecting this block in parallel with one of the other three. With this arrangement, no shut down is necessary in order to make a test. The dummy is first inserted in the empty block and then the parallel fuse is pulled; thus there is no break in the current supply.

JAMES P. MARSHALL.

Providence, R. I.

Drying Out Water-Soaked Generator Coils

FLOODING of a 75-kw. belt-driven generator one night made it necessary to pump out the water in the engine room the following morning and also to make arrangements for putting the generator in working condition again.

After the water was pumped out, the generator was cleaned first by removing in a superficial way, the sediment, and then gasoline was employed.

Due to the existing circumstances it was decided to dry out the generator armature coils by driving the generator at about one-third speed while a No. 8 solid copper wire short-circuited the armature terminals.

To indicate the temperature of the coils a thermometer was taped between two of the main coils at the top of the machine, waste being packed tightly against the thermometer bulb in order to insulate it from the room temperature. The two coils selected were the ones which seemed to be operating at the highest temperature.

Shifting the field rheostat did not have much effect on the temperature of the coils, and the exciter rheostat was inoperative because of an open circuit in its resistence; therefore, increasing or decreasing the temperature of the coils was accomplished by occasionally altering the engine speed. Although an ammeter is ordinarily used to determine the amount of current flowing, none was available in this case.

Readings were taken at 15-min. intervals so as to determine whether the temperature of the coils was going up or down. During the day the temperature was maintained at 80 deg. and at night at 60 deg. C. At the end of a 26-hr. drying period, all but one of the coils had dried out and seemed to be in good condition. Usually, however, about a week is required for this drying out when no external heat is applied.

As the machine was basket wound, one coil would affect the operation of the machine a great deal. However, it was finally decided to finish the drying out process by operating the machine under normal conditions and so the terminal voltage was increased gradually to the operating voltage of 440. After a while the coil, which was suspected of being defective, began to heat. Therefore, it was necessary to cut this coil out of the circuit.

As the cost of drying this coil would nearly balance the cost of replacing it, and it might be defective and require replacing in the end anyway, it was decided to replace it. After the job was finished, the coils were sprayed with an air drying varnish. The only spray gun available was an insecticide spray. The piston was removed and a ¼-in. pipe nipple screwed in the wooden plug in the end. An air hose was attached to this.

GRADY H. EMERSON.

Birmingham, Ala.

Conveyor and Breaking Roll Driven by One Motor

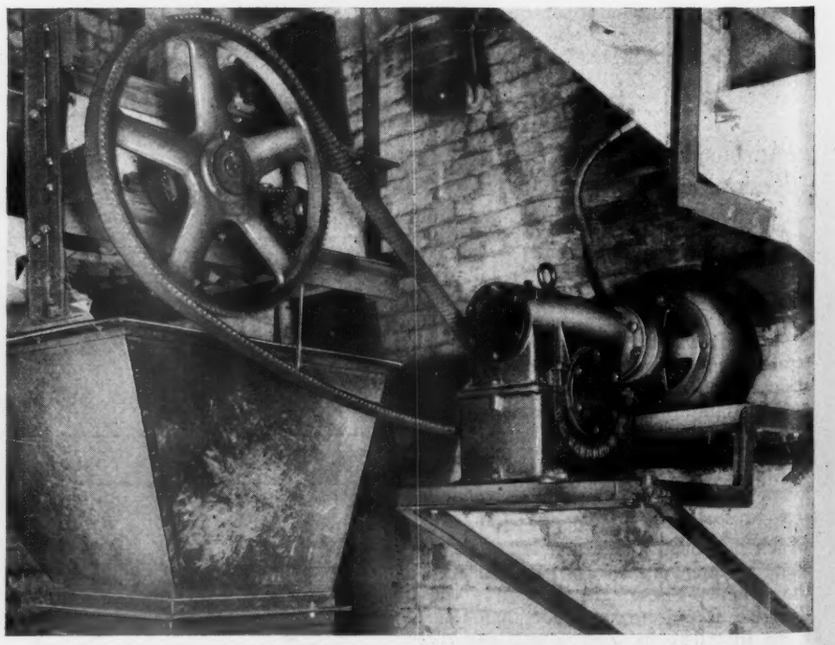
AN interesting drive, although it is not subjected to extremely hard service, is in connection with a cooling conveyor and crushing or breaking roll in one Chicago plant. The product, when it is discharged from the dryer, must be cooled and the caked material broken up for ease in handling and also so that it will not pile up and choke the hopper leading to the pulverizer or grinder.

After studying the problem it was decided to attach the crushing roller to the discharge end of the conveyor. A slat conveyor about 70 ft. long was used for carrying the caked material while cooling. Instead of using a separately driven crusher, a crusher roll was placed to take the material as it discharged from the end of the grinder, crush it between roll and the slats on the conveyor, and drop it into the hopper of the grinder, as shown at the left in the accompanying illustration.

By connecting the crusher roll with the driving shaft on the conveyor one drive suffices for both. The connection between the crusher roll and the conveyor and also the drive from the conveyor to the speed reducer are both made by American High-Speed Chain Co. A Ganschow worm-gear speed reducer with a single reduction ratio of 100 to 1 is direct connected to the motor through a flexible coupling. The two-level platform for mounting the speed reducer and the motor, as shown by the accompanying illustration, is also of interest.

* * * *

A SINGLE DRIVE operates both the conveyor and the crushing roll. This Ganschow worm-gear speed reducer with a reduction of 100 to 1 drives the two units as a single unit through American High Speed chain. The slat conveyor for cooling the product discharges through a crushing roll into a hopper.



Adjustable-Speed A.C. Motor Drive for Textile Machines

A NEW method of driving textile finishing machines when operated in tandem, and driven by a.c. motors, has been instituted in a number of textile mills. This application, requiring the use of a motor with shunt speed characteristics, has heretofore involved the use of d.c. motors.

With the new method, the G. E. Type BTA motor is used, which is a self-contained, adjustable-speed, a.c. motor with shunt characteristics. The motors in each group of machines are synchronized by means of a compensating gate placed between each unit and the next. This gate consists of a vertical frame of wood or metal on which are located three more rollers over which the cloth passes. One of these rollers moves in a vertical plane between guides, with fixed limits of travel, and is counterweighted to permit free movement. The remaining rollers are stationary.

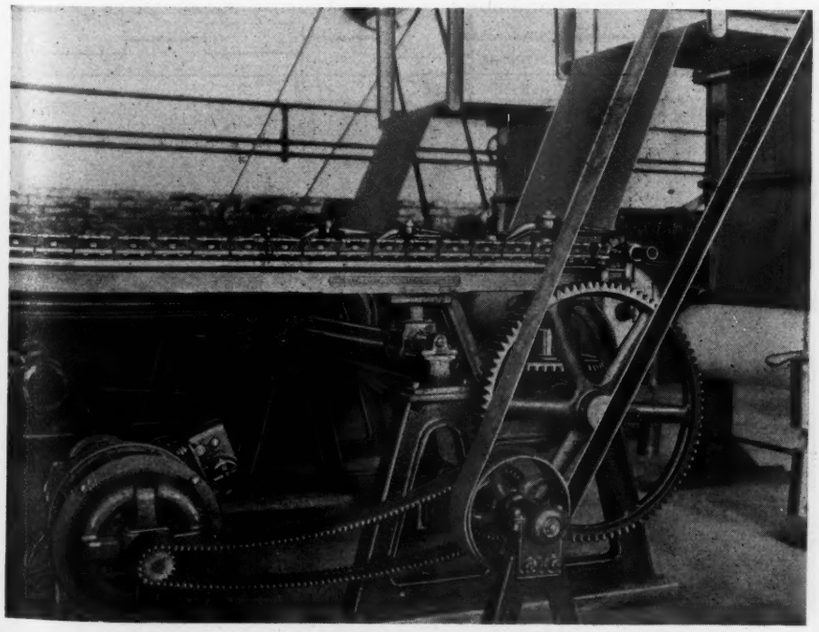
The main motor, driving the tenter frame, is equipped with a fractional-horsepower motor which is operated by a push-button station and changes the speed of the main motor by shifting its brushes. Such changes in speed, being communicated to the cloth passing through the rollers, raise or lower the movable roller on the compensating gate. The vertical movement of the movable roller is immediately followed by a corresponding change of speed in the motors driving the other machines in the finishing group, such as mangles, dry cans, etc. The speed of these secondary motors is governed by the position of their brushes, which are moved through mechanical or electrical connection to the floating roller in the compensating gate. Through this interconnection or interlocking, the speed of all the driving motors is maintained at the same rate, and as a result the speed of the cloth is constant.

One control panel governs all the driving motors, and is so arranged that all the motors may be run in tandem or individually. By the use of push buttons at the main control station all motors may be started, jogged or stopped simultaneously, the speed increased or decreased, and the control changed from tandem to individual or vice versa. When operating individually, separate push-button stations at each machine control each driving motor, and the compensating gates are not in use.

When the secondary or follower motors can be conveniently located near their respective compensating gates, mechanical control is used: that is, changes in speed of these motors are governed by mechanical connection of the brushes to the floating roller in the compensating gate. Where this is impracticable, electrical control is used. In such cases, each follower motor is equipped with a pilot motor for shifting its brushes and thus controlling the speed. This pilot motor is governed by a limit switch mounted on the gate.

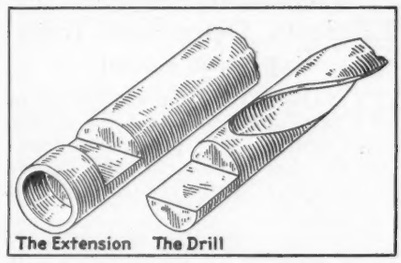
* * * *

A TENTER FRAME AND WINDER in a two-motor tandem drive. The Type BTA motor is equipped with a pilot motor (as shown at the right above the motor) for shifting its brushes and thus controlling its speed. The compensating gate is shown at the right.



Lengthening a Drill Shank for Emergency Service

NO MECHANIC who has spent a year or two in repair work or factory maintenance has failed to need a long drill at some period of that experience. Long drills are not a standard product. When ordered in advance, however, one can get the drill flutes cut on a bar which will be left uncut in any length desired. Such drills are very handy indeed for the industrial engineer's gang but they do not help out in an emergency because they are too expensive to keep very many on hand.



ADDING TO SHANK OF DRILL. A piece of cold drawn steel about ¼-in. larger than the drill size is cut off and drilled for the shank of the drill to enter a distance of ½ to 1 in., according to its diameter.

* * * *

The sketch shows how, in an emergency, anyone with a lathe and a milling machine can make a long drill in an hour's time or less. A straight shank drill, jobber's length or otherwise, is milled or filed across the end, cutting to the center line.

A piece of cold-drawn steel, about ¼-in. larger than the drill size and of whatever length is needed, is cut off, steady-rested in the lathe and drilled for the shank of the drill to enter a distance of ½ to 1 in., according to its diameter. Then, just cutting into the drilled hole and extending lengthwise beyond it, a flat is milled crosswise to the center line, as shown. When the drill is inserted in this socket, it is positively driven and, though not intended for heavy or manufacturing work, it will do all that repair men want.

DONALD A. HAMPSON.
Plant Superintendent,
Morgans & Wilcox Manufacturing Company,
Middletown, N. Y.

Tank for Oil Hardening Small Work

TO MAKE a successful job of hardening small pieces in oil they must be immersed immediately when at the correct heat. To simplify this operation a repair shop recently made up a special arrangement consisting of two metal cans, one fitting into the other. The smaller can is furnished with a handle, which is bent down across the front of the can. A small hole is cut in the top of the can.

In this particular shop the acetylene torch is used for heating when hardening and the work is laid on top of the can alongside the hole. When the piece reaches the proper temperature it is pushed into the hole and drops immediately in the half-filled can of oil. The operator then lifts the inner can up and down by the handle to keep the oil in circulation about the work. When the work has cooled sufficiently the inner can is raised above the surface of the oil so that the piece can be readily removed without the usual "fishing" around that sometimes occurs when work is simply dropped into a tank of oil.

These two cans were welded out of scrap material. For the small amount of such work done in this shop, this device has proved its value.

Hamilton, Ontario, Can. W. KENDALL.

Gasoline Engine Efficiency Determined from Explosion Count

BY COUNTING the explosions of a gasoline engine and doing a little simple figuring, it is possible to determine the approximate efficiency of any gasoline engine of the hit-and-miss type of governing.

Subtract the number of explosions per minute made by the engine when it is pulling no load at all, from the number of explosions per minute when pulling full load. Then divide the remainder by the number of explosions per minute when pulling full load, and the quotient is the so-called "mechanical efficiency."

For a gasoline engine that explodes 95 times per minute when pulling full load, and 24 times per minute when pulling no load at all, the difference is 71. In other words, 71 of the explosions are utilized when pulling full load, whereas 24 of them are lost in overcoming the internal friction in the engine.

Going back to the rule, divide 71 by 95 and the quotient indicates that the mechanical efficiency of the engine is a little less than 75 per cent—a rather low efficiency. It can be bettered by reducing to the minimum, the number of explosions per minute when running unloaded.

W. F. SCHAPHORST.
Mechanical Engineer,
Newark, N. J.

Connecting-Up Silent Chain to Engine Shaft to Drive Reciprocating Pumps

PROBLEMS incidental to changing over from steam engine to motor drive are often complicated by the necessity of using as much of the old equipment as possible to keep the capital investment low. A good example of this was in connection with the substitution of a motor and chain drive for a steam engine at the St. Louis, Mo., plant of the Hydraulic Press Brick Company, as shown in the accompanying illustrations.

Brick manufactured by this company is formed in special hydraulic presses. The engine used in the former drive had a single steam cylinder which was located just ahead of the two pumps, as shown in the sketch. The steam cylinder, therefore, drove the pistons in both pumps which provide the hydraulic pressure for operating the brick presses. A flywheel and belt pulley are mounted on the crank shaft. The pulley, in turn, is belted to a lineshaft which drives a system of crushers and conveyors for feeding the press.

* * * *

The problem was to attach the motor to this reciprocating unit and also retain as much of the old equipment as possible. How this was done is shown in the sketch and in the reproduction of the photograph. The governor pulley on the engine shaft was removed to get space for mounting the sprocket for the Morse silent chain drive from the motor. This gave 15 in. in which to center the sprocket between the engine bearing and the flywheel hub.

The 50-hp., 485-r.p.m. motor drives the old engine shaft at 68 r.p.m. through a 1½-in. pitch Morse chain, 5½ in. wide. This is a speed reduction of approximately 7 to 1 on 6-ft. centers. The entire drive is housed in a steel case, 9¼ in. wide.

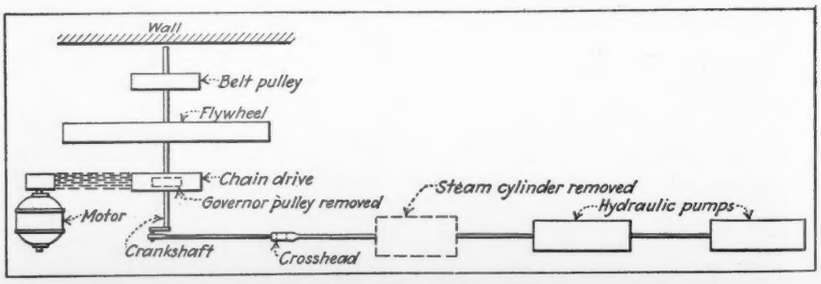
Cutting Out Coils in Emergency Repairs to A. C. Motors

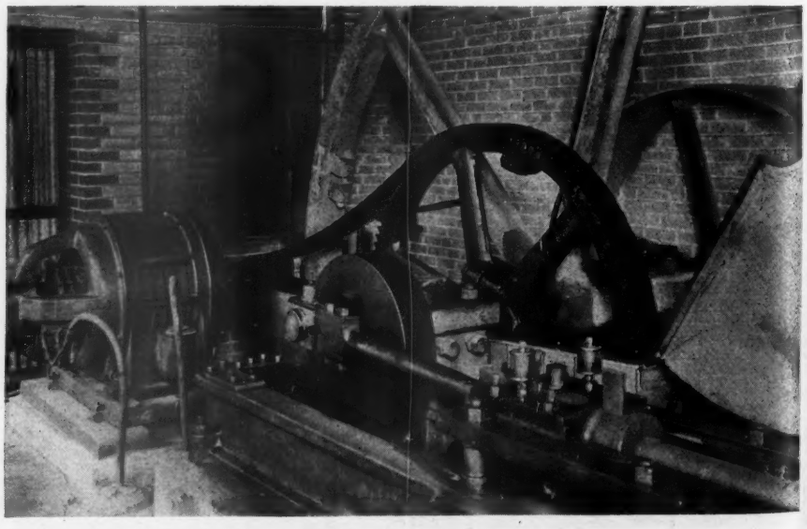
WHEN productive capacity in a certain plant was being pushed to the limit to fill a rush order, the 7½-hp., 220-volt a.c. motor driving the most important drill press refused to run. After making several attempts to start it, smoke was seen coming out of the frame. Inasmuch as there were no spares in stock, it was decided to disassemble this motor to see if emergency repairs could be made that would enable the drill press to be used until the end of the shift.

The end frame opposite the pulley was removed and when the rotor was taken out it was noticed that the rotor had rubbed on the stator, stalling the motor when under load and consequently burning out a coil. This trouble was then traced to worn bearings which someone had neglected to oil.

Upon examining the motor, it was found that a new type of waterproofing and oilproofing compound had been used, as no connections were visible and the only indication of damage was where the paint had been scorched. On removing this compound it was found that the coils were wound in a group of three per pole per phase, and the connection from one point to another was near the stator slots, making it difficult to work on. However, the winder cut out the damaged coil and a test was made for the end of the coil which was in series with it. The hairpin turn made by the coil winder was then pulled out of the burned slot and connected to the coil next to it. This made an unbalanced condition in that only two coils were left in this group, whereas it originally had three in series across the line.

In such cases, some repairmen make it a practice to balance all groups by cutting a coil out of the other phases, but under emergency conditions this is not advisable, on account of the extra time and work involved. Practically any motor will stand a 10 per cent voltage increase; so with 11 coils in series across the line, with the stator connected single delta, the voltage across each coil would be 20 volts, instead of 18 volts, as in the original group. This represents a 2-volt rise per coil, or an increase of 11 per cent, which was permissible under the circumstances. Although the unbalancing produced in one phase is not desirable,





MOTOR AND SILENT CHAIN ON ENGINE SHAFT DRIVING PUMPS. Removing the governor pulley provided space for the chain sprocket on the engine shaft. The steam cylinder was removed, as shown in the sketch, but otherwise the connection to the hydraulic pump cylinders is the same reciprocating drive as when the engine was used. This permitted modernizing the drive with a comparatively small outlay.

it does not appear to interfere seriously with the operation of a motor. I have known motors to run for years with several coils cut out. Certainly no harm will result from allowing a motor to run in this condition for a short time, assuming that the voltage impressed on the remaining coils is not beyond the limits mentioned above.

The connections were then checked and found to be correct; so while the windings were given two coats of air-drying insulating varnish new stock bearings were installed. The motor was then assembled and put back into service.

GRADY H. EMERSON.
Birmingham, Ala.

Determining Width of Belts From Alignment Chart

THE width of a belt required to transmit a given amount of power depends on the allowable tension which may be placed on the belt, the speed of the belt and the arc of contact between the belt and pulley. This problem may be solved by means of the belt-tension formula and the formula for horsepower of belts. For leather on cast iron the co-efficient of friction varies from 0.3 to 0.5. Assuming the minimum value of 0.3, the formula becomes:

$$Hp.=[TS(1-e^{-0.005235})]\div 33.000$$

from which the accompanying chart was constructed. Solution of the formula is difficult for one not familiar with natural logarithms or the use of a "log-log" slide rule, and takes considerable time if it is necessary to make several trials to arrive at the desired proportions.

An example will best illustrate the use of the chart. Assume a set of values as follows:

Tension T = 100 lb. per in. of width;
Speed S = 2,000 f. p. m.;
α = 150 deg. arc of contact;
Hp. to be transmitted = 20.

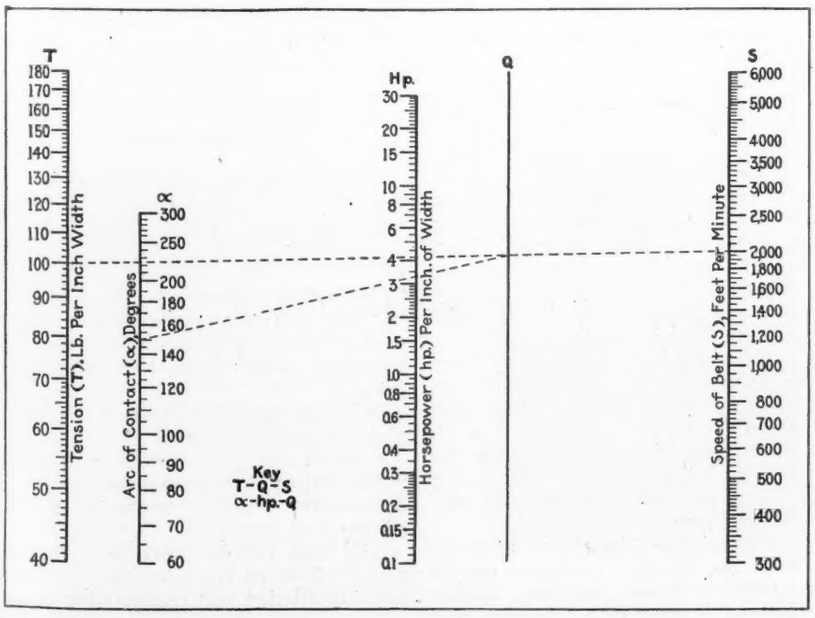
Place a straight-edge across the chart between the points given on the T and S scales, as shown by the dotted line, and mark its intersection with the line Q. Place the straight-edge again from this point on Q to the value given on the α scale, and read the value on the $Hp.$ scale, which in this case is 3.3 hp. per in. of width. Since the horsepower to be transmitted is 20, the width of the belt must be 20 ÷ 3.3 or approximately 6 inches.

The maximum allowable value of T may be obtained from the manufacturer of the belt, or by testing a piece in a tension machine and then applying a suitable factor of safety. In case the arc of contact is not the same for both pulleys of a system, the smaller should be used, as slippage would tend to occur first on that pulley. The chart may be used to solve for any other quantity in case the width is known, so long as the two readings with the straight-edge are taken on the proper scales, according to the key given on the chart. If it is desired to find T, all other values being known, the reading α-$hp.$-Q is taken first, then S-Q-T. If readings are carefully taken, the greatest error will be less than 5 per cent.

Mooresville, Ind. K. M. WHITE.

* * * *

CHART FOR DETERMINING BELT WIDTH with straight-edge. Knowing the important characteristics of a drive, such as speed, tension (estimated), arc of contact and power to be transmitted, the belt width is determined as follows: Assume T (tension) is 100 lb. per in. in width; S (speed) is 2,000 f.p.m.; α (arc of contact) is 150 deg. and 20 hp. is to be transmitted. Place the straight-edge on T and S scales as shown by dotted line and mark intersection with Q. Again place the straight edge on Q and α scale and read the horsepower per inch on the $hp.$ scale.



Undersized Motors on Grinder Cause of Trouble

PROBABLY the most interesting phase of any line of work is that which presents the unusual. That which is outside the ordinary sphere of everyday life is generally the most perplexing because of its simplicity, or on the other extreme, because of its complexity.

I recall a situation that is not often found which arose when a firm installed a huge grinder unit complete with motors rated at 30 and 40 hp., respectively. As soon as this unit was placed in service, a complaint came in that the motors heated excessively, causing frequent interruptions to allow them to cool. This installation was a two-drive job, with the machine in the center and a motor on each end driving in opposite directions.

Upon my arrival, I found the machine shut down and requested the operator to run the grinder unloaded. Each motor was started separately, to give me an opportunity to observe its acceleration, after which we allowed them to run while I checked the wiring. This I found to be correct, but much improvement could have been made in its lay-out, for obviously it was a cheap job. I found the smaller motor to be heating a little out of proportion to its apparent load. The 40-hp. motor was out of line just enough to destroy the outboard bearing. The motors were then stopped and it was found that the 40-hp. motor coasted for 16 min., whereas the smaller one stopped in 10 min. They were started again, and a light load was fed to the grinder. This load caused the motors to slow up and both began to heat seriously.

Using a voltmeter and ammeter, I found the voltage to be 242 between phases, 334 to the outside wires, and 196 at the collector rings, but the ammeter indicated that something was wrong when the 30-hp. motor, rated 60 amp., drew 80 amp. with the grinder running empty, and 136 amp. at a very light feeding. The normal speed of 1,155 r.p.m. dropped to 1,135 r.p.m. at no load, and to 1,075 r.p.m. on a light load, with the voltage dropping to 217. During this 10-min. period, the temperature rise was from 14.5 deg. C. on the cold motor to 54 deg. C. on the iron, 42 deg. C. on the coils and 38 deg. C. on the rotor laminations.

These readings looked so peculiar that I rechecked the wiring and other details but could find nothing wrong. It was obvious, then, that the motors were overloaded.

The wattmeter indicated 9.6 kw. input for the 30-hp. motor, but when the 40-hp. motor was started its input rose to 30.08 kw., or about 40 hp. Since both indications were in the same proportion, there was nothing else to do but tell the customer that his motors were too small for the no-load capacity of his grinder; and as these motors had been specified by the manufacturer of the grinder it was clearly up to that firm to replace them.

Further investigation revealed that the manufacturer had made a mistake in specifying 30- and 40-hp. motors, as they should have been rated 60 and 75 hp. respectively.

E. J. MORRISSEY.
Asst. Chief Engineer,
Western United Gas and Elec. Company,
Aurora, Ill.

PRACTICAL BOOKS

for Your Personal Library

Every man who aspires to larger responsibilities should build up a professional library containing carefully selected volumes on subjects related to his work. Copies of the books which are reviewed here may be obtained from the publishers mentioned.

Principles and Practices of Upkeep Painting

Published by E. I. du Pont de Nemours & Company, Paint and Varnish Division, Public Ledger Building, Philadelphia, Pa. Fabrikoid binding, 239 pages, 6x9 in., illustrated. Price $1.50.

THIS fifth edition is considerably enlarged and extended in scope. A color chart supplements the numerous illustrations. This book has been written as a practical aid to plant superintendents or others responsible for the maintenance of industrial property and equipment, and as a help to architects and engineers in the protection of new construction. It covers in simple, practical fashion, modern painting practice for all types of exterior and interior surfaces.

Although thoroughly practical and easily understandable, the book deals with the subject of up-keep painting from a scientific standpoint and in a comprehensive maner. It would be difficult to name a painting requirement that is not covered in one or another of the 26 chapters.

Emphasis is placed on the importance of paint and varnish in the industrial world and a chapter is devoted to modern paint and varnish making. Woods and their treatment and the causes of decay are the subjects of chapters which impart information necessary to the complete understanding of painting methods and the necessity of protection against the elements and other causes of the deterioration of wood surfaces. Other chapters treat the various other phases of the subject of painting.

Induction Motor Practice

By A. M. Dudley, Engineering Supervisor of Development, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. Published by McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York, N. Y. Cloth, 6x9 in., 236 pages; illustrated. Price $2.50.

IN THIS book a well-known designing engineer brings his experience to operating men and students to help them in the solution of practical problems involving induction motor characteristics.

The book explains clearly, simply, accurately, with a minimum of mathematics, just what an induction motor is and how it works.

It takes up in detail such topics as the rotating magnetic field, speed-torque characteristics, mechanical considerations and the complete performance figured from the circle diagram.

An especially interesting chapter is Chapter XI—The Question Box. Here are answered a number of questions on induction motor performance that have been asked by practical engineers and electricians.

The book is a companion volume to the author's widely-known "Connecting Induction Motors."

Foundry Work

By R. E. Wendt, Head Instructor in Foundry Practice, Purdue University. Second Edition, 236 pages, 5x7½ in., 193 illustrations, $2.00. McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York, N. Y. 1928.

SOUND, practical information on molding, dry-sand core-making, melting and mixing of metals, and the problems of foundry managers.

The first part of the book takes up some of the fundamental principles in the manufacture of castings, such as the kinds of castings used; a layout of a floor plan of a foundry; the selecting, tempering, and care of molding sand; facings and their uses; gating and feeding castings; reinforcing sand when molding; securing cores with chaplets; making gaggers; and using the molder's tools.

The second part presents exercises in bench and floor molding dealing with the making of two- and three-part molds; making molds in a pit, with sweeps, and in open sand; gating patterns and making follow boards; mounting patterns on match plates. Many types of machines are shown, such as squeezing, rollover stripping plate, jolting, and sand slinging. Mold fillers and sand mixing machines are described. Exercises in dry-sand core making are provided, and the principles of core making are explained.

In the third part, melting furnaces for gray iron, brass, and aluminum are illustrated and explained. This part also deals with the melting of metals and the making up of mixtures for gray-iron and non-ferrous castings are explained, and machine used for such work are shown.

The fourth part deals with problems such as the foundry executive usually encounters. These problems include laying out a floor plan; showing how the cupolas are to be lined, charged, and operated; computing mixtures from chemical analysis; making up charging sheets; dealing with melting losses and melting ratios; testing the iron for strength, computing the cost per pound of making castings; finding the weight of castings from a drawing; computing the weight necessary to hold down copes; designing flasks; and comparing different methods of molding that have been developed.

The Manual of Industrial Safety

By Sidney J. Williams, C. E. Director, Public Safety Division, National Safety Council. Published by A. W. Shaw Company, 660 Cass St., Chciago, Ill. Cloth, 5½x8¼ in.; 194 pages. Price $2.50.

THIS manual attempts to set forth the information needed by a man who devotes all or part of his time to industrial safety work. The information given is based upon the experience and practices of the thousands of industrial organizations with which the author has come in contact during twenty years of accident service as an industrial executive and as chief engineer for the Wisconsin Industrial Commission and the National Safety Council.

Safety organization and methods are given the major emphasis and the greater portion of space in the book because accident prevention is, in the main, a problem of organization and education. However, the essentials and place of engineering in the application of safeguarding the men and the machines, are discussed from the basic principles involved rather than to attempt to cover the specific hazards in the hundreds of different industries. Appendix C, however, contains a list of the processes and hazards of a large number of industries. Another list of Safety Codes available should be helpful in the design and installation of mechanical safeguarding.

Power's Practical Refrigeration

Second Edition, compiled by L. H. Morrison, Editorial Staff of "Power." 259 pages, 6x9 in., illustrated, $2.50. McGraw-Hill Book Company, 370 Seventh Ave., New York, N. Y. 1928.

THE first edition of this practical book on refrigeration was so successful that a second edition with a somewhat wider scope has been prepared.

This book is for the practical operator of a refrigerating plant.

Considerable space has been devoted to the subject of indicating the ammonia compressor, which is so important to efficiency of operation.

The book includes very sensible and sound advice on the selection, purchase and installation of refrigerating machinery.

NEW EQUIPMENT

For Plant Operation and Maintenance

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these new devices which are designed to improve plant operation or reduce operating and maintenance costs.

Starter for Squirrel-Cage Motors

A NEW, full-voltage motor starter with a maximum rating of 7½ hp. has recently been announced by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

This new Linestarter is claimed to be particularly suited for the starting and protection of small induction motors driving various types of machines where remote control with complete protection to operator, motor and machine is desired. It can also be used as a magnetic primary switch for wound-rotor motors within its capacity.

An unusually desirable feature of this starter is its adaptability to either hand or automatic reset after an overload.

Westinghouse 7½-Hp. Linestarter

It comes equipped with hand reset of the thermal overload relay, but if automatic reset is desired the hand reset lever can readily be removed and automatic reset obtained.

High-Bay Lighting Unit

ANNOUNCEMENT is made by the Holophane Company that its new, high-bay unit No. 691-AL for 750-, 1,000- and 1,500-watt lamps, and No. 681-AL for 300- and 500-watt lamps supersede the old types Nos. 661-AL and 651-AL respectively.

The new high-bay units are larger in diameter and deeper than the old types, and it is claimed that as they include more solid angle of light flux from the lamp, they are more efficient and deliver 30 per cent more light to the work.

In addition to this improvement in illumination the new units have been redesigned to incorporate many mechanical improvements as follows: 1. The holding tripod is made of $\frac{11}{32}$-in. spring steel. 2. The prongs of the tripod holder are clamped between two collars, instead of welding as before. 3. A clamping ring is placed over the tripod holder that keeps the prongs 120 deg. apart and thereby automatically maintains the socket in the center of the reflector. 4. All of the metal parts are cadmium plated.

Holophane High-Bay Lighting Unit

Surface Switch

THE No. 782 expulsion-type surface switch recently announced by The Bryant Electric Company, Bridgeport, Conn., is made especially for inductive loads and for controlling three-phase a.c. motors up to 2-hp. rating. It is reversible, triple pole, with a rating of 20 amp. at 250 volts, 10 amp. at 600 volts.

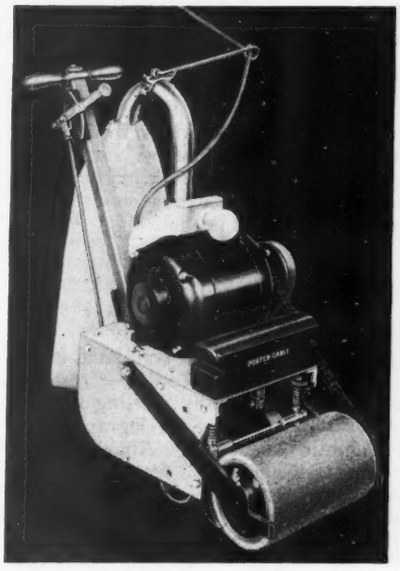
This switch has a composition base and handle, the latter indicating the position of the switch. Three covers are available; No. 783 is a cast-iron cover finished black, designed to be attached to conduit fittings made by the Crouse-Hinds Company, The Appleton Electric Company, The Columbia Metal Box Company, and The V. V. Fittings Company. No. 784 is a cast-iron cover with a sherardized finish; otherwise it is the same as No. 783. No. 785 is a stamped steel cover with insulating lining, finished in black enamel. These covers are dust tight and are suitable for use in machine shops, mills and so on.

This switch has insulating disks made of laminated phenolic composition, and, it is claimed, has high-heat insulation throughout. The switch blades are of heavy phosphor bronze with heavy brass contacts.

Bryant Expulsion-Type Surface Switch

Floor Surfacer

ANNOUNCEMENT is made by The Porter-Cable Machine Company, Syracuse, N. Y., of a new floor surfacer designated as the Speedmatic. According to the manufacturer this is the lightest heavy-duty floor surfacer on the market. By careful designing more than 100 lb. of excess weight have been eliminated, without reducing the pressure on the sanding drum.



Porter-Cable Speedmatic Floor Surfacer

In this machine a drum 12 in. wide and 6¾ in. in diameter carries the abrasive paper and is driven at a speed of 1,150 r.p.m. (2,000 f.p.m. surface speed) by a 1½-hp., 1,800-r.p.m. single-phase motor. A direct-current motor will be supplied if desired. The weight of the complete outfit is 290 lb., and it is claimed that a maximum pressure of 142 lb. can be applied to the drum.

Dust produced by the sanding operation is drawn by suction into a bag. A 7-in. fan driven at 5,000 r.p.m. creates the vacuum for the dust-collecting equipment.

New Fixture Switch

THE McGill Manufacturing Company, Valparaiso, Indiana, has announced an improvement in the Levolier, Cat. No. 61 fixture switch.

This new switch, it is claimed, is

New Levolier Fixture Switch

especially adaptable for industrial lighting, store lighting and the lighting of restaurants, assembly halls and gymnasiums—now tending toward the use of higher and higher wattages.

It is also claimed that its use saves on run of conduit—from outlet box to switch; saves on wall switch and labor of installation. The actual size is 1⅜ in. x ⅞ in.—and, therefore, suitable for shallow ceiling pans and canopies of store and office fixtures.

All of the current carrying parts are of heavier section; the make and break is so designed that arcing effect is minimized. This new switch will in fact take the initial destructive surge of a cold 500-watt gas filled Mazda lamp and stand up in continuous service over long periods of time, it is said.

Inclosed Motor

A NEW inclosed and ventilated motor known as the Sterling Cross-line has been introduced by Sterling Electric Motors, Incorporated, Telegraph Road at Atlantic Avenue, Los Angeles, Calif.

One of the principal features claimed for this motor is the design. It can be pipe ventilated, copper shielded and ventilated, or totally inclosed which, it is claimed, makes it suitable for many kinds of services in various industries. The motor operates on either 220 or 440 volts by changing external connections.

Sterling Inclosed Cross-Line Motor

This type is made in all sizes from ¼ to 30 hp. and in all speeds. It is equipped with protected ball or roller bearings as required. It is also stated that the same motor can be furnished for single-phase operation in sizes ranging from ¼ to 5 hp. in all speeds.

Insulated Lamp Guard

THE Ericson Manufacturing Company, Box 2060, Cleveland, Ohio, have just perfected an insulated lamp guard, which is intended for use around switchboards and other places where it is essential to have an insulated guard.

This guard consists of a metal framework to which the necessary thickness of rubber is added, the whole being entirely covered. The rubber, which is of high insulating qualities, is put on in layers. It is claimed that in this way great strength and toughness are secured.

C. & E. Insulated Guard

For reflector guards the interior of the reflector shade is coated with aluminum paint after the rubber is put on.

Although it is said that these guards will resist considerable abrasion and wear, a special rubber band and projecting nibs have been devised, which can be added to the guard so that if it is dragged across concrete floors, all the wear will come upon the rubber band or the projecting rubber nibs.

Welding Electrodes

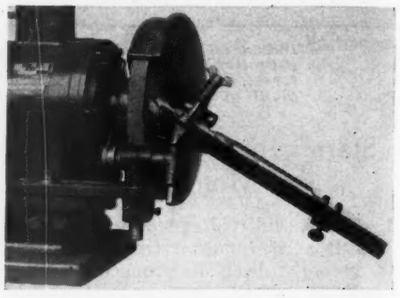
THE Fusion Welding Corporation, 103rd Street and Torrence Avenue, Chicago, Ill., has announced the development of two new, mild steel welding electrodes.

On account of their color, these electrodes will be known as Blue Streak and Yellow Jacket, respectively. The Blue Streak is claimed to be a fast flowing electrode that is especially suited to the welding of the medium and lighter gage plates and sheets.

The Yellow Jacket is a surfaced electrode, and is designed to give extreme penetration when used with high current on heavy material.

Attachment for Grinding Twist Drills

A NEW twist drill grinding attachment has been added to the line of The Standard Electrical Tool Company, Cincinnati, Ohio. It is stated that the



Standard Electric Tool Company Attachment for Grinding Twist Drills

attachment is easily interchanged with the regular tool grinding rest and can be quickly mounted in place, thus giving double service to the tool grinder. According to the manufacturer, gages are not required, because the attachment is equipped with a graduated micrometer screw and its adjustment makes the lip-lengths identical.

A medium-grade grinding wheel of 60 grit is recommended. This wheel should be kept well dressed. The attachment is used for grinding either straight- or taper-shank twist drills ranging in size from ¼ to 1½ in. diameter, and can be furnished for any Standard Electric Tool Company grinder with wheels up to 12 in. diameter.

Three-Speed Crane

FLEXIBILITY equal to that of steam cranes is one of the features claimed for the new American gasoline-driven three-speed crane, made by the American Hoist & Derrick Company, St. Paul, Minn. This crane has an automotive-type gear shift that permits the use of low gear for a powerful start, intermediate for average crane work and traveling, and high gear for rapid traveling.

It is claimed that this new three-speed crane embodies many new features of

American Three-Speed Gasoline Crane

design. The machinery deck revolves on 20 bronze-bushed conical rollers, which makes slewing easier and reduces friction. The machinery deck is locked to the car body at the outer circumference of a bull gear by an American interlocking gib ring. It is claimed that this construction distributes the load and stress instead of concentrating them on a king pin.

Cranes are made in capacities ranging from 12 to 30 tons.

Electric Saw

A PORTABLE, electrically-driven saw, Type CC, has been placed on the market by The Crowe Manufacturing Corporation, 225-9 East Third St., Cincinnati, Ohio.

The driving motor is of General Electric make and is of the universal type, designed for operation at 110 or 220 volts, alternating or direct current. The saw is equipped throughout with heavy-duty ball bearings. Moving parts are said to be carefully balanced to eliminate vibration.

The body of the saw is made of an aluminum alloy, which decreases the weight and makes the saw easier to handle.

An easily-adjusted depth gage forms part of the safety guard and makes possible any depth of cut up to $4\frac{1}{8}$ in.

Angle Head

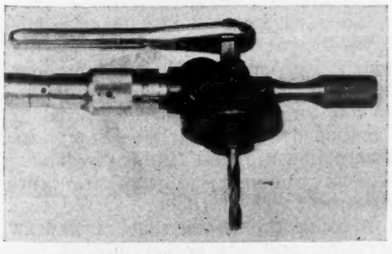
MARKETING of a new angle head has been announced by the Stow Manufacturing Company, Inc., Binghamton, N. Y. This tool is designed for drilling in both wood and metal in out-of-the-way places where an ordinary electric or hand drill cannot be used on account of space limitations. It is operated through a flexible shaft that may be driven by an electric drill or separate small motor, or it may be belted to a lineshaft.

This angle head is usually furnished in the $\frac{1}{2}$-in. capacity, but may be had in other sizes with a $1\frac{1}{4}$-in. screw feed with ratchet handle, the socket taking Morse taper-shank drills. When space permits a chuck may also be used.

The overall measurement is 7 in. from point to point.

It is claimed, that it is especially adapted for applying shock absorbers on automotive equipment, and drilling large steel castings that are too heavy to move.

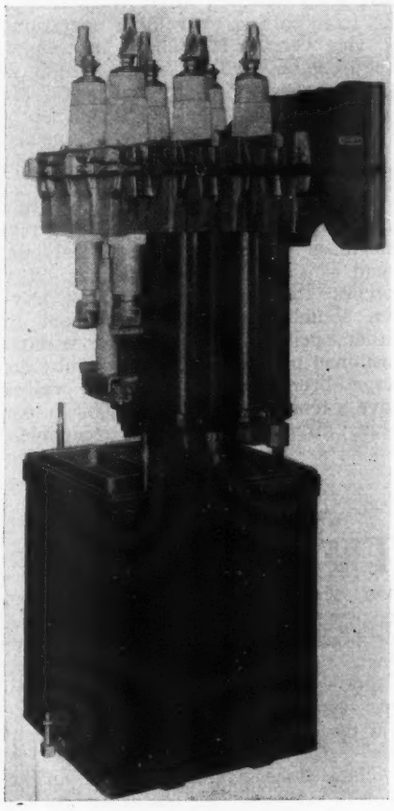
Stow Angle Head for Flexible Shaft Drive



Oil Circuit Breaker

AN OIL circuit breaker, known as Type D-131, of relatively high interrupting capacity and comparatively small over-all dimensions, has been placed on the market by the Condit Electrical Manufacturing Corporation, Boston, Mass.

The frame is said to be of exceptionally heavy and rugged construction to afford the rigidity necessary to assure proper functioning of the mechanism,



Condit Type D-131 Oil Circuit Breakers

and strength to resist unbalanced stress and strain.

Double-tank construction is used. An individual inner tank per pole is overlapped several inches by the supporting frame.

These inner tanks are supported by a heavily ribbed steel cradle secured by rods suspended on springs set in the frame. This construction provides for the absorption of the mechanical shock incidental to rupturing a heavy short circuit.

A large outer, or spill, tank is also provided which fits around the other tanks and is supported from the frame by steel rods.

The main, current-carrying contacts are Condit inverted, laminated brushes of special design which will, it is claimed, withstand extremely high inrush currents. The exceptionally heavy arcing contacts are said to reduce materially the arcing on interruption of the current in the circuit.

The Type D-131 oil circuit breakers are built for 400, 600, 800 and 1,200 amp. at 15,000 volts, and 1,600 amp. at 7,500 volts, with an estimated interrupting capacity of 7,000 amp. at 15,000 volts. They are furnished with two, three, and four poles, single throw, manually or completely electrically operated.

Combination Bench Grinder

A COMBINATION grinder for sharpening edged tools, buffing and cleaning was recently brought out by the Black & Decker Manufacturing Company, Towson, Md. The spindle is driven at 2,400 r.p.m. by a universal, ball-bearing motor for use on 32-, 110-, 220- or 250-volt circuits.

The grinder is furnished complete with a 5-in. grinding wheel on the left spindle and a 6-in. wire wheel brush on the right spindle. Buffs may be readily interchanged with the wire-wheel brush.

Standard equipment includes 6 ft. of cable, equipped with a standard attachment plug and a switch in the line; one tool rest, and one wheel guard.

Combination Tractor-Welder

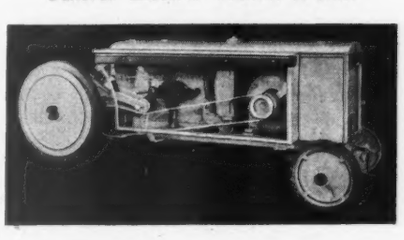
AN IMPROVED combination of electric arc welder and Fordson tractor is now offered by the General Electric Company, Schenectady, N. Y.

The principal equipment consists of a standard Fordson tractor, belt-connected to a Type WD-300-A, 25-volt, 300-amp. 1-hour rated, 1,750-r.p.m., ball-bearing generator. This unit is mounted directly on the tractor and is protected by metal canopy and canvas side curtains. Other equipment includes governor, power take-off, waterproofed pulleys on engine and generator, belt and belt tightener, industrial (disk-type) rubber-tired wheels front and rear, extension frame, offset crank, head and tail lights, and battery and charging control. As optional equipment the following are available: light industrial (spoke-type) wheels front and rear; standard Fordson farm wheels front and rear, and any other desired accessories.

The over-all length of the unit is 12 ft., height 4 ft. 8 in., width 5 ft. 2 in. The net weight is approximately 4,900 lb.

The battery which supplies current for the lights and ignition is charged while the welding generator is operating. It is provided with an ammeter and automatic cutout.

General Electric Tractor-Welder



High-Speed Chain Hoist

A NEW Model K Cyclone Hoist, manufactured by The Chisholm-Moore Manufacturing Company, Cleveland, Ohio, has recently been announced and placed on the market.

The new hoist is constructed on the same gyrating yoke principle that is to be found in the previous Cyclone model hoist manufactured by the same company.

Among the improvements incorporated in this new unit is the addition of anti-friction bearings at all rotating points. Altogether eight ball bearings, four roller bearings and one Timken thrust roller bearing in the lower swivel hook help to increase the new hoist's efficiency it is claimed.

One of the most important changes was made in the four eccentric roller bearings. In the old models the rollers in these bearings were loose and had to be carefully fitted into their cage at the time of assembling the hoist. In the new Model K Cyclone these holler bearings are built in one complete unit which does away entirely with the ordinary loose rollers.

Another important improvement is the long-life lift wheel. This wheel is constructed of a new steel alloy, developed by the company, and is claimed to be the hardest material available for this service.

Then, it is also claimed that all parts are strictly interchangeable. The entire mechanism of the hoist is enclosed in a dust-proof, oil-tight frame. This feature makes possible a minimum of attention for the hoist needs to be packed with grease only once a year under ordinary usage. It is built in units from ¼ to 6 tons.

Because of the equal distribution of material used in construction, the hoist is very light in weight, making it possible to carry the smaller models easily from one job to another.

Model K Cyclone Hoist

Cutting and Welding Torch

THE Alexander Milburn Company, Baltimore, Maryland, has recently developed a new lightweight torch that can be used for cutting or welding by merely interchanging the tips. It is made to operate with either oxygen and acetylene, oxygen and hydrogen, or other gases.

This torch, known as the Milburn Type RI, obviates the necessity of using two torches, or of disconnecting the hose from the torch valves when changing from cutting to welding operations or vice versa. It is light in weight, weighing only 40 oz. This weight is advantageous for continuous work. It is claimed that the torch efficiently welds the lightest or heaviest metals, and will cut metal upwards of 12 in. in thickness.

Important features claimed for this combination torch are: it has only two gas tubes (made of stainless steel) instead of three tubes common in other torches; the high-pressure cutting oxygen thumb button remains fixed in either open or closed position without sustained pressure from the thumb; the forged-bronze torch head and valves have a tensile strength of 60,000 lb. per sq.in.; all valves are readily accessible.

Commutator Stones

THE Martindale Electric Company, 1252 West Fourth Street, Cleveland, Ohio, announces the marketing of its new double-duty commutator stones for touching up commutators and slip-rings.

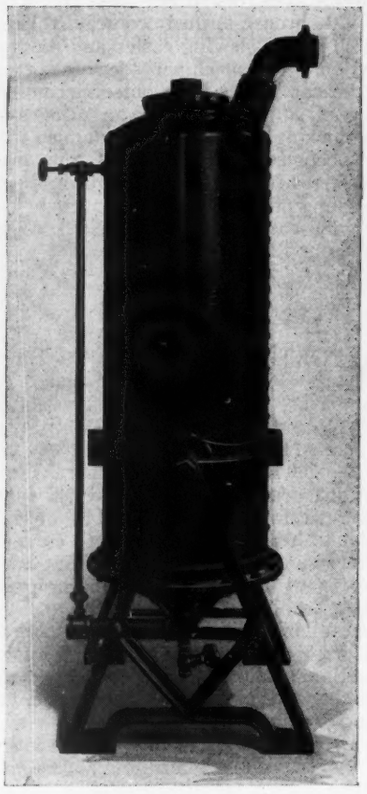
One end of these stones is made from this company's coarse (cutting) grade and the other end from its fine (finishing) grade of abrasive.

These stones are furnished in various sizes convenient for carrying in the pocket or tool kit.

Fire Protective Equipment

WHAT is known as the Phomene Accumulator has been put on the market by the Pyrene Manufacturing Company, 560 Belmont Ave., Newark, N. J. This is a foam-making device designed for permanent installation to provide automatic fire protection for particularly free-burning hazards. The operation of the outfit is as follows:

The accumulator normally contains a charge of a dry powder that produces a thick foam when mixed with water. When fire breaks out, the opening of one or more standard sprinkler heads located at the hazard allows water to be forced into the accumulator and the foam mixture is discharged. An automatic valve that has been especially designed for this service is used in connection with the accumulator and serves the double purpose of turning water on as soon as a fire starts, and turning it off again as soon as the foam discharge has been completed. The object of the latter action is to prevent an excess of water overflowing the inflammable contents of tanks protected by this system.



Phomene Accumulator Made by Pyrene Manufacturing Company

If desired, an electrical thermostat control may be used in place of sprinkler heads located at the hazard.

The Phomene accumulator is intended for the protection of varnish or paint dipping tanks, lacquer mixers, oil storage tanks and similar hazards. Under a water pressure of 50-60 lb. per sq.in. the accumulator will, it is claimed, discharge 2,400 gal. of foam in about 2½ min. With a lower water pressure the rate of discharge is slightly lower.

Electric Saw

A NEW light-weight model, electrically-driven saw, designated as J, has been announced by Skilsaw, Inc., 3814-24 Ravenswood Ave., Chicago, Ill. This model weighs only 11 lb., but it is claimed that the motor will develop ½ hp., which is sufficient for cutting dressed lumber up to 2 in. in thickness, with a saw blade 6 in. in diameter.

A chrome-nickel steel shaft is used in this saw, and ball bearings are employed throughout. A kerf guide and approved safety guard are built into the frame. The base is, of course, adjustable for any depth of cut desired.

Standard equipment includes: one combination rip and cutoff saw blade; steel carrying case; adjustable rip fence attachment; 15-ft. rubber-covered cord with connections; one tube of Skilsaw lubricant, and one socket wrench.

Protective Coatings for Concrete

TWO new preparations, known as Stainproof and Masterseal, for use in protecting new concrete, marble and similar surfaces, have been developed by The Master Builders Company, 7016 Euclid Avenue, Cleveland, Ohio.

Stainproof is a rather thick liquid that is applied to the floor, like paint. It dries to a tough coat that is said to be stain-preventing and wear resisting, and is allowed to remain on the floor until all painting- plastering, electrical work, etc., are finished, and the building is ready for occupancy. Then the Stainproof can easily be removed by soaking with water and scrubbing off.

It is also said to assist materially in properly curing the concrete.

Masterseal is a transparent and colorless liquid that is applied like paint and penetrates the pores, sealing them against moisture absorption.

It is claimed that Masterseal protects the walls of a building from disintegration, stain efflorescence, mildewing and other disfigurations which are primarily due to moisture absorption, by rendering the surfaces non-absorbent.

Bitumen Spray Gun

APPLICATION of liquids by spraying has been extended to include bitumen products, by the Quigley Furnace Specialties Company, 26 Cortlandt Street, New York, N. Y., which has brought out the Quigley Bitumen Gun. It is an adaptation of this company's refractory gun, and consists of a cast-iron cylinder from which the material is forced by a piston capable of exerting high pressure. The gun is enclosed in a steel housing, mounted on wheels. Its capacity is 15 gal., enough to cover approximately 400 sq.ft. of surface.

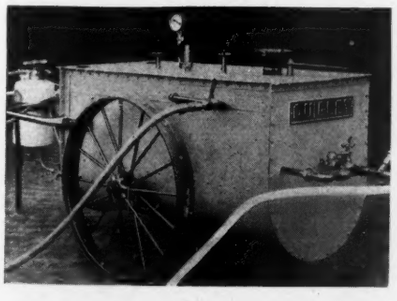
Two men are required to operate the outfit, one man at the nozzle, the other charging the gun. The temperature of the material in the gun is regulated by a small, self-contained kerosene burner. A large-scale thermometer shows the temperature of the material.

It is claimed that this gun will spray or shoot liquids of practically any consistency or temperature through an insulated, metallic hose, for any distance up to several hundred feet, and that volume and pressure are under easy control.

Material is forced through the hose with a drop in temperature said to be not over 3 deg. for each 25 ft. of length.

The discharge end of the nozzle can be bent at any angle, so that the operator can reach places otherwise inaccessible.

Quigley Bitumen Gun



High-Mounting Lighting Unit

ONE OF THE recent developments in industrial lighting equipment by the Ivanhoe Division of The Miller Company is a line of high-mounting units.

These units are designed for use in outdoor areas of all kinds and for use indoors when a large area must be lighted and the units necessarily mounted 25 ft. or more above the floor.

Lamps from 300- to 1,500-watt rating can be used with this equipment, which, it is claimed concentrates and redirects the light to the working plane, with minimum loss and high efficiency.

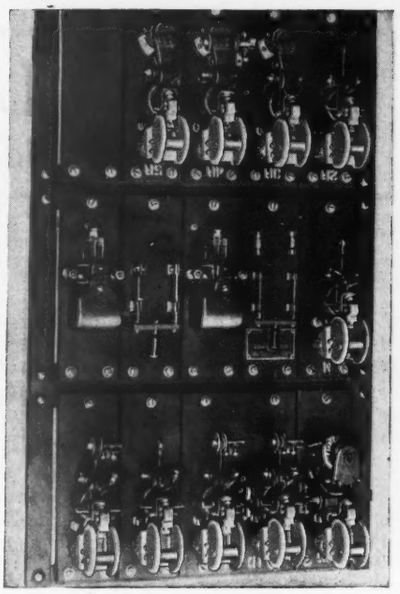
Ivanhoe High Mounting Lighting Unit

These new units are easy to install, owing to their light weight, yet they are of sturdy construction. It is said that these units will not rust and are unaffected by smoke, fumes or atmospheric conditions and are easily cleaned, due to the new Ivanite finish.

Improved Magnetic Blowouts on D. C. Mill Contactors

IMPROVEMENTS in the design of the magnetic blowouts on their mill contactors which, it is stated, will result in a material reduction in maintenance expense, are announced by The Cutler-Hammer Manufacturing Company. These improvements are the result of research and a series of life tests, which were undertaken coincident with the development of the inductive time-limit type of controller for steel mill applications. The design finally adopted incorporates those changes which showed up best under the actual tests.

A 300-amp., type 142, butt-contact type mill contactor, operating at 200 per cent load and alternately making and breaking a 600-amp., 250-volt circuit, gave an average life of 263,000 operations for each set of contacts. The tests ran about two million operations and required eight renewals of contacts. At the end of the two-millionth run, the blowout shields were still in excellent condition, it is said. The accompanying illustration shows a typical steel mill controller using the new contactors.



Cutler-Hammer Magnetic Blowouts on D. C. Mill Contactors

These improvements in contactor life are expected to effect considerable annual saving in renewal parts. In addition, the cost of maintenance and inspection will be materially reduced, it is stated, because the contacts and blowout shields will not need to be renewed as frequently as before.

Shell-Type Motor

A SQUIRREL-CAGE motor for use in various kinds of woodworking machinery and other equipment requiring high-speed motors has been put on the market by the Lincoln Electric Company, Cleveland, Ohio. This motor, which is of the so-called shell type, is an all-welded design, and can be supplied in 3-hp. and 5-hp. ratings.

The 3-hp. unit has an external diameter of 6.5 in. and an external length of 4.5 in. The 5-hp. motor is of the same diameter and is 6 in. in length. Both motors can be furnished for operation on either two- or three-phase, 60-cycle current and a speed of 3,600 r.p.m.

The stator is composed of laminated sections arc-welded together. The rotor is also entirely arc-welded and provided with either a straight or tapered bore.

A definite advantage is claimed for this type of construction as the welding does away with the necessity of a solid shell about the laminations and also replaces the conventional rivets, thus keeping the amount of the active field at a minimum.

As normally used, the stator is secured in the frame of the machine and the rotor is mounted on the tool shaft.

Trade Literature

you should know about

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog desired, as given in these columns.

MATERIAL HANDLING EQUIPMENT—Bulletin No. 98 devotes 24 well illustrated pages to numerous installations of G-W elevating and conveying machinery.—Gifford-Wood Company, Hudson, New York.

HYDRAULIC JACKS—A new folder recently issued describes several types of hydraulic jacks for automobile and shop use. Tables of sizes, dimensions and capacities are also included—Black Hawk Mfg. Company, Milwaukee, Wis.

ELECTRIC FURNACES—A new bulletin recently issued describes in detail the application of electrically heated kilns to the ceramic industry.—The Electric Furnace Company, Salem, Ohio.

BATTERIES — Exide batteries of the chloride accumulator type, in sealed and open glass jars, are described in bulletin No. 201.—The Electric Storage Battery Company, Philadelphia, Pa.

WRENCHES — The Husky common sense line of socket wrenches and other accessories is described in catalog No. 28.—Husky Wrench Company, Milwaukee, Wis.

GUIDE—The 1927 edition of the buyers guide, containing a list of the distributors of Monel metal and pure nickel products, is now available.—The International Nickel Company, Inc., 67 Wall Street, New York.

MOTORS—Type T heavy duty Reliance motors for direct current, with ball and roller bearings, are described in bulletin No. 202.—Reliance Electric & Engineering Company, Ivanhoe Road, Cleveland, Ohio.

BAROMETERS—A new booklet recently issued pictures 20 interesting heat-treating jobs using Brown Pyrometers.—The Brown Instrument Company, Philadelphia, Pa.

GASOLINE TRUCK—A new folder describes and illustrates several interesting applications of the Clark Truclift—Clark Tructractor Company, Battle Creek, Mich.

SCREWS—The 1928 catalog contains 111 pages of illustrations and descriptive matter on screws, bolts, rivets and nuts. The reference tables include the American Standard Screw Thread, and the recently adopted standard dimensions and tolerances for screws, bolts, rivets and nuts.—Pheoll Manufacturing Company, 5700 Roosevelt Road, Chicago, Ill.

MOTORS — Price book No. 79 lists alternating current single phase and polyphase, direct current compound wound, and various other types of motors manufactured by this company.—The Master Electric Company, Dayton, Ohio.

SPEED REDUCERS—Catalog No. 48 contains 48 pages describing the line of herringbone gear and spur gear speed reducers manufactured by this company.—Palmer-Bee Company, Detroit, Mich.

TRUCK—The Lyon Utility truck, an all-metal truck for warehouse and factory use is described and illustrated in bulletin No. 101.—Lyon Iron Works, Greene, N. Y.

HOISTS—Vertical and horizontal capstan winches and single and double drum winches, self-contained units complete with electric motor and gasoline drive are described in bulletin No. 27.—Silent Hoist Winch & Crane Company, Inc., 762-772 Henry Street, Brooklyn, N. Y.

INSULATING MATERIALS — Catalog G.E.A 603 contains a detailed description of insulating materials produced by this company.—General Electric Company, Merchandise Department, Bridgeport, Conn.

ELECTRIC FURNACES — New bulletin No. 5 illustrates and describes Ajax Northrup electric furnaces and motor generator sets.—Ajax Electro Thermit Corporation, Division of Ajax Metal Company, Trenton, N. J.

PUMPS—The water works pumping equipment of the city of Haverhill, Mass., is described in a four-page leaflet recently issued.—DeLaval Steam Turbine Company, Trenton, N. J.

MOTORS — Bulletin No. 151 contains a description of the new line of Wagner air-jacketed, totally inclosed, pipeless motors.—Wagner Electric Corporation, 6400 Plymouth Avenue, St. Louis, Mo.

INSULATING MATERIAL—"Come Adventuring" is the unique title of an unusual book recently issued. It gives complete information on C-H cold-molded Thermoplax, what it is, and the uses to which it can be put.—The Cutler-Hammer Mfg. Company, Milwaukee, Wis.

UNIT HEATERS—A 15-page catalog describes the construction and illustrates a number of applications as well as giving engineering data on the Venturafin method of heating.—American Blower Co., Detroit, Mich.

CLUTCH—A new bulletin recently issued briefly describes and illustrates the LGS spring clutch and shows varied installations and suggests practical applications.—LGS Manufacturing Company, Indianapolis, Ind.

LIGHTING—Catalog No. 800 contains 48 pages describing metal reflectors and fittings for industrial lighting.—Ivanhoe Division of the Miller Company, Cleveland, Ohio.

CIRCUIT BREAKERS—Bulletin No. 580 contains 15 pages of information on Roller Smith inclosed circuit breakers types ESF, ES, and EI.—Roller Smith Company, 233 Broadway, New York City.

WHEELS—A circular recently issued, describes the Metzger line of unbreakable wheels in sizes ranging from 2½ up to 20 in. in diameter, for use on all different types of warehouse, platform hand lift trucks and trailors.—The Metzger Company, Inc., Grand Rapids, Mich.

PROTECTIVE EQUIPMENT — Catalog No. 76 lists the Noark line of safety switches, fuses and fuse accessories, service boxes, underground boxes, and Noark molded products and line material.—Colt Patent Fire Arms Manufacturing Company, Hartford, Conn.

POTHEADS — The complete line of G & W potheads, underground cable boxes, and oil and air disconnects, is covered in catalog No. 27.—G. &. W. Electric Specialty Company, 778 Dante Avenue, Chicago, Ill.

HARDWARE—Catalog No. 44 describes and illustrates the elevator door hardware manufactured by this company.—Richards Wilcox Manufacturing Company.

FITTINGS—The fifth edition of the Kondu threadless fitting catalog is now available.—Erie Malleable Iron Company, Kondu Division, Erie, Pa.

REDUCTION UNITS—Bulletin No. 106 contains 18 pages on the design and application of Cleveland worm gear reduction units.—Cleveland Worm and Gear Company, 3292 East 80th St., Cleveland, Ohio.